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While scientific minds are wrestling with the problem of determining the nature of electricity, engineers may comfort themselves with the reflection that, no matter what the outcome of the theoretical discussion, practice will not be affected. Whatever electricity may be—matter or energy—it certainly is possessed of "isness," that essential of all things.

Our esteemed contemporary, the *Journal of Electricity, Power and Gas,* advocates the use of trolley-driven automobiles. There are few roads suitable for automobile travel that are not paralleled by a pole line from which the trolley wires could be suspended. The picture drawn of a ride in a luxurious trolley-fed automobile through the magnificent scenery of Southern California is most attractive, and, no doubt, will appeal strongly to those who started for Boston in the recent automobile contest in the only electric-gasoline automobile that started and which gave out on the first section of the run, through the disablement of the gasoline engine.

ELECTRIC LIGHTING AND PHOTOMETRY.

At the meeting of the American Institute of Electrical Engineers last week, Professor C. P. Matthews read a paper describing his new photometer for incandescent lamps. This brings up the subject of the imperfect methods used in our light engineering. Not only have we no entirely satisfactory standards, but our methods of making comparisons and measurements are tedious and subject to error. And, worst of all, our methods of converting electrical energy into light are extremely inefficient. While we have no accepted mechanical equivalent of light, we know that over ninety per cent of the energy supplied to the electric lamp is not converted into light. The fault, of course, lies in the system, and not in the lamps, which are about as mechanically perfect as it is possible to make them.

Professor Matthews has done much to improve our apparatus for measuring the light output of electric lamps, and his latest photometer is a decided advance in the construction of apparatus of this class. Much missionary work will have to be done, however, before the central stations will consider the adoption of this sensible instrument. The lighting station operator is generally satisfied with a very simple photometer, if, indeed, any instrument of this kind is included in the station equipment; and, in use, generally one measurement is considered sufficient. Since a lamp gives out light in all directions, this simple method of rating them is about as sensible as trying on a waistcoat only in order to determine the fit of an entire suit of clothes.

In purchasing lamps, variations of ten per cent in candle-power are allowable, and after a lamp has been installed it is allowed to depreciate twenty per cent before it is condemned.

All this seems absurd enough, and the whole problem is in no way simplified by the fact that the user of electric lights pays for energy, and not for light, and there is no fixed relation between these two quantities.

Incandescent lamps can be so constructed as to give almost any distribution of light desired, and we do not see why the lamp manufacturers should not standardize the methods of coiling lamp filaments, so that the purchaser could obtain any type of distribution he may wish. If this were done carefully, doubtless one measurement of any such lamp, made in a predetermined direction, would enable the lamp to be satisfactorily rated. Much comment and energy have been expended in attempted solutions of these important problems without any great advance having been made. The only consolation the electrical engineer can draw from this state of affairs is the doubtful one that other lighting systems are in a much worse condition than the electric.

IMPROVING THE LOAD CURVE OF CENTRAL STATIONS.

The desirability, and in many cases the necessity, of increasing the day load in such a way as to increase the economy of operating central stations is a well-worn theme, but this in no way detracts from its importance. It was therefore not surprising to find it assigned as a topic for discussion at the recent meeting of the Ohio Electric Light Association.

In this question, the consumer is as much concerned as the station operator, for he can only hope for better rates for light and power if the cost of the production is decreased. In a well-designed and well-operated station to-day there is little opportunity for material improvement in machinery or management, so that practically the only chance for a reduction in the charges for electrical power lies in decreasing the time during which the machinery is idle. In this way, the output of the station can be increased without a corresponding increase in the cost of production. It was stated at the

convention that the machinery of a lighting plant was practically idle, so far as earnings are concerned, for seventy per cent of the time. This is a condition which is probably not met with in any other manufacturing business.

The possibilities of increasing the day lighting load are small, so that the station manager must rely largely upon the sale of power for motors and for heating in seeking probable custom for these hours.

No startling suggestions were made at the convention, although the matter was fully discussed. The importance of actively soliciting business was urged, and suitable lines were laid down for conducting this work. This is good advice, and is already practised by many companies. Electric lighting does not differ from other lines of business, and these have found it not only advantageous, but necessary, to go after custom. This is particularly true in introducing new applications.

The companies should not wait for orders to come to them, but should seek for new applications of their products, and should approach the prospective customer with a good argument and an attractive proposition. They should not wait for the energetic manufacturer to think out the value of adopting electric driving. The proposition should come from them before he ever thought of it. And once having established an entering wedge, the use of electric power is sure to extend, not only in the one factory in which it is first introduced, but in all others.

The use of exhaust steam for heating was also considered at the meeting. It was stated that this would increase the cost of operating the plant about twenty-five per cent, but the income to the plant from this source would cover this, leaving all revenue brought in by the sale of electrical energy as pure profit. The station could then afford to make attractive propositions to power users, and thus materially improve the load curve. The sale of steam for heating once begun a vigorous effort should be made to improve the day load of the plant, if this is to operate to the best advantage.

In connection with steam heating, something might be done in the sale of electric power for cooking. It might not take a very great reduction in price to build up a very desirable business of this.

SCIENCE AND ENGINEERING.

The never-ending controversy between those who are studying and teaching what has been called pure science and those who are devoting their life and work to the study of applied science or engineering was strikingly brought forward at the recent meeting of the British Association.

Is it not about time that this unfortunate condition should be ended? Each line of work is largely dependent on the other for advancement, and becomes more so every day. Pure science can no more grow without the aid of application than can engineering conquer new fields without falling back on science for new ideas.

The engineering side of this discussion was warmly presented by Dr. John Perry, of the Royal College of Science, London, who pleaded for recognition of the useful side of science. Dr. Perry has spent many years teaching at an engineering college and has done a great deal of practical engineering work, and his opinion should bear the combined weight of teacher and engineer.

In his eagerness to cut off everything that can not be shown to be immediately useful, he goes so far as to claim that not only Greek and Latin are useless, but that time spent by engineers in learning French and German is thrown away. This is going to extremes. The plea that any engineer can get an English translation of all valuable foreign articles is hardly valid, because these translations can not be satisfactory unless made by a technical man. Nevertheless, there is some question whether in the vast majority of cases the time spent in the study of French and German, as at present taught, is not largely wasted. It is a very small minority of graduates who have a reading knowledge of the technical literature of either of these languages. The inevitable conclusion must be drawn that either the method of teaching these languages is wrong, or the time given to them is too short.

There is one phase of this that should not be overlooked here. The engineer must be an engineer of men, as well as of material, and it can not be denied that the study of foreign languages will be of benefit in this connection, in addition to the training given by a thorough study of any subject whatever. However, it is unfortunate that the student can not acquire a reading knowledge at the same time, for this is unquestionably a valuable aid.

The present method of teaching mathematics are also criticised by Dr. Perry, and here he is not alone. We can not see that mathematics loses anything of its beauty and value by being taught in a useful way. No engineer in these days can afford to neglect this valuable tool, and it is a fact that here again few of the young aspirants to engineering rank have a facility in the application of mathematics.

There is no denying the value of the training given by the cold logic of mathematical reasoning; but nothing of its truth would be lost if the application were taught at the same time. Since it is absolutely necessary for an engineer to know how to use his formulæ readily, he can surely claim the right to such instructions as will give him this facility. Who would expect a man to become an expert machinist who had simply listened to lectures on the handling of tools?

On the other side of the controversy, the advocates of teaching pure science claim that true scientific work can only be done by ignoring all possible utility and by a diligent search for truth. That there is good reason in this can not be denied, for nature persistently withholds her secrets from the biased seeker. But our advanced civilization of to-day rests upon applied science, and the ultimate test of the value of any study must be in its utility.

Each has some right on its side, and the controversy is the more unfortunate because there does not seem to be any necessity for it. A little more charity on the part of each would materially help to clear away misunderstandings. Two fundamental truths should be accepted by both sides: First, whatever the subject taught, the student should be taught to

use it as well as to know it; second, he who would take up original scientific research must lay aside all other thought, and seek for the whole truth.

In this connection another question might be raised in regard to this country. Are we doing our share of the purely scientific work? Statistics seem to show that we are not. We are doing engineering work which can not be surpassed, but this, in the eyes of the world, will not absolve us from doing our share of scientific research. Science is supposed to be taught in all schools, and is undoubtedly more generally taught in this country than anywhere else in the world, yet the results are less than can be shown by any of our principal rivals.

What are the causes that give rise to this condition? Is not one of them the eminently "practical" spirit of the country, which measures the value of a thing by its availability for immediate use? This spirit seems to be inborn. What instructor in science is there who has not been frequently irritated by the question "but what is the use of it?" Is our method of teaching science, after all, the best? Has not the laboratory method been carried to excess? From the primary school child who can not learn to spell "cat" without one before him, to the college student who goes through a certain number of experiments and gets the reports in his notebook, the idea of things overshadows that of principles. There is no place in the system for the scientific imagination which Tyndall considered so important. Students are actually bewildered by the complicated apparatus that is necessary to demonstrate some scientific principle. By the time it is set up, its workings understood and the readings taken, both time and mind are exhausted, and there is nothing left for the chief idea. This truth is illustrated by an instance mentioned by Dr. Perry. His laboratory refused the gift of a large and elaborate testing machine, because the student in using it would lose sight of the tiny specimen.

But are these two conditions wholly to blame? Is not the chief cause found in the fact that those with the greatest aptitude for scientific research have so little time to spend upon it? In Europe and England scientific discoveries are made, in almost all cases, by instructors at the universities, but there they have the leisure and time to do it. We have yet to learn practically that it is of greater advantage to the university and to the state to cut short the routine work, and to be satisfied with a small amount of teaching from the man who is able to do a great deal of original work.

ENGINEERING.*

This section has had sixty-six presidents, all different types of engineer. As each has had perfect freedom in choosing the subject for his address, and each has known of the rule that presidential addresses are not subject to debate afterward, and as, being an engineer, he has always been a man of originality, of course he has always chosen a subject outside of his own work. An engineer knows that the great inventions, the great suggestions of change in any profession, come from outsiders. Lawyers seem like fish out of water when trying to act as law-makers. The radical change that some of us hope to see before we die in the construction of locomotives will certainly not come from a locomotive superintendent who can not imagine a locomotive which is not somehow a lineal descendant of the Rocket.

Hence it is that in almost every case the president of this section has devoted a small or large part of his address to the subject of the education of engineers. I grant that every president has devoted his life to the education of one engineer—himself—and it is characteristic of engineers that their professional education proceeds throughout the whole of their lives. Perhaps of no other man can this be said so completely. To utilize the forces of Nature, to combat Nature, to comprehend Nature as a child comprehends its mother, this is the pleasure and the pain of the engineer. A mere scientific man analyzes Nature; takes a phenomenon, dissects it into its simpler elements, and investigates these elements separately in his laboratory. The engineer can not do this. He must take Nature as she is, in all her exasperating complexity. He must understand one of Nature's problems as a whole. He must have all the knowledge of the scientific man, and ever so much more. He uses the methods of the scientific man, and adds to them methods of his own. The name given to these scientific methods of his own or their results is sometimes "common sense," sometimes "character," or "individuality," or "faculty," or "business ability," or "instinct." They come to him through a very wide experience of engineering processes, of acquaintance with things and men. No school or college can do more than prepare a young man for this higher engineering education which lasts through life. Without it a man follows only rule of thumb like a sheep following the bell-wether, or else he lets his inventiveness or love of theory act the tyrant.

I think we may assume that there never yet was an engineer worth his salt who was not fond of engineering, and so I shall speak only of the education of the young man who is likely to be fond of engineering. How are we to detect this fondness in a boy?

Mistakes must be made, and in my experience the Anglo-Saxon boy can stand a very great deal of mismanagement without permanent hurt, and it can do no kind of boy any very great harm to try him on engineering for a while.

Well-equipped schools of applied science are getting to be numerous, but I am sorry to say that only a few of the men who leave them every year are really likely to become good engineers. The most important reason for this is that the students who enter them come usually from the public schools; they can not write English; they know nothing of English subjects; they do not care to read anything except the sporting news in the daily papers; they can not compute; they know nothing of natural science; in fact, they are quite deficient in that kind of general education which every man ought to have.

I am not sure that such ignorant boys would not benefit more by entering works at once than by entering a great engineering school. They can not follow the college courses of instruction at all, in spite of having passed the entrance examination by cramming. Whereas after a while they do begin to understand what goes on in a workshop; and if they have the true engineer's spirit, their workshop observation will greatly correct the faults due to stupid schoolwork.

What we want to see is that a boy of fifteen shall be fond of reading, shall be able to compute and shall have some knowledge of natural science; or, to put it in another way, that he shall have had mental training in the study of his own language, in the experimental study of mathematics and in the methods of the student of natural science. Such a boy is fit to begin any ordinary profession, and whether he is to enter the church, or take up medicine or surgery, or become a soldier, every boy ought to have this kind of training. When I have advocated this kind of education in the past I have usually been told that I was thinking only of boys who intend to be engineers; that it was a specialized kind of instruction. But this is very untrue. Let me quote from the recommendations of the 1902 Military Education Committee.

"The fifth subject which may be considered as an essential part of a sound general education is experimental science; that is to say, the science of physics and chemistry treated experimentally. As a means of mental training, and also viewed as useful knowledge, this may be considered a necessary part of the intellectual equipment of every educational man, and especially so of the officer, whose profession in all its branches is daily becoming more and more dependent on science." When statements of this kind have been made by some of us in the past, nobody has paid much attention; but I beg you to observe that the headmaster of Eton and the headmaster of St. Paul's school are two of the members of the important committee who signed this recommendation, and it is impossible to ignore

*Abstract of the opening address by Professor John Perry, M. E., D. Sc., LL. D., F. R. S., Section G., British Association.

it. As to English, the committee say: "They have no hesitation in insisting that a knowledge of English, as tested by composition, together with an acquaintance with the main facts of the history and geography of the British Empire, ought in future to hold the *first* place in the examination and to be exacted from all candidates." The italics are mine. It will be noticed that they say nothing about the practical impossibility of obtaining teachers. As to mathematics, the committee say: "It is of almost equal importance that every officer should have a thorough grounding in the elementary part of mathematics. But they think that elementary mechanics and geometrical drawing, which under the name of practical geometry is now often used as an introduction to theoretical construction, should be added to this part of the examination, so as to ensure that at this stage of instruction the practical application of mathematics may not be left out of sight." It seems probable that at the end of another five years no average boy of fifteen years of age will have been compelled to attempt any abstract reasoning about things of which he knows nothing; he will be versed in experimental mathematics, which he may or may not call mensuration; he will use logarithms, and mere multiplication and division will be a joy to him; he will have a working power with algebra and sines and cosines; he will be able to tackle at once any curious new problem which can be solved by squared paper, and he will have no fear of the symbols of the infinitesimal calculus. When I insist that a boy ought to be able to compute, this is the sort of computation that I mean. Five years hence it will be called "elementary mathematics." Four years ago it was an unorthodox subject called "practical mathematics," but it is establishing itself in every polytechnic and technical college and evening or day science school in the country.

I must not dwell any longer on the three essential parts of a good general education which lead to the three powers which all boys of fifteen ought to possess; power to use books and to enjoy reading; power to use mathematics and to enjoy its use; power to study Nature sympathetically.

When a boy or man of any age or any kind of experience enters an engineering college and wishes to learn the scientific principles underlying a trade or profession, how ought we to teach him? Whether he comes from a bad or good school, whether he is an old or young boy or man, approach his intelligence through the knowledge and experience he already possesses. This principle involves that we shall compel the teacher to take the pupil's point of view rather than the pupil the teacher's; give the student a choice of many directions in which he may study; let lectures be rather to instruct the student how to teach himself than to teach him; show the student how to learn through experiment and how to use books, and, except for suggestions and help when asked for, leave him greatly to himself. If a teacher understands the principle he will have no difficulty in carrying it out with any class of students.

It was for such boys that the courses of instruction at the Finsbury Technical College (the city and guilds of London Institute) were arranged twenty-two years ago. It was attempted to supply that kind of training which ought already to have been given at school, together with so much technical training as might enable a boy at the end of a two years' course to enter any kind of factory where applied science was important, with an observing eye, and understanding brain and a fairly skillful hand.

The professors were given a free hand at Finsbury, and there were no outside examiners. I need not dwell upon the courses in chemistry and physics; some critics might call the subjects *rational* chemistry and applied physics; they were as different from all other courses of study in these subjects as the courses on rational mathematics and mechanics differed from all courses elsewhere. The course on mechanics was really one on mechanical engineering. There were workshops in wood and iron, not to teach trades, but rather to teach boys the properties of materials. There were a steam engine and a gas engine, and shafting and gearing of many kinds, and dynamos which advanced students in turn were allowed to look after under competent men. There was no machine which might not be experimented with occasionally. Elementary and advanced courses of lectures were given; there was an elaborate system of tutorial classes, where numerical and squared paper exercise work was done; there were classes in experimental plane and solid geometry, including much graphical calculation; boys were taught to make drawing-office drawings in pencil only, and tracings and blue-prints, such as would be respected in the workshop, and not the ordinary drawing-class drawings which can not be respected anywhere; but the most important part of the training was in the laboratory in which every student worked, making quantitative experiments. An offer of a 100-ton testing machine for that laboratory was made, but refused; the advanced students usually had one opportunity given them of testing with a large machine, but not in their own laboratory. I consider that there is very little educational value in such a machine; the student thinks of the great machine, and not of the tiny specimen. Junior students loaded wires and beams, or twisted things with very visible weights, and saw exactly what was happening, or they studied vibrating bodies. Many hours were devoted to experiments on a battered, rusty old screw-jack, or some other lifting machine, its efficiency under many kinds of load being determined, and students studied their observations, using squared paper, as intently as if nobody had ever made such experiments before. There was one piece of apparatus, an old flywheel bought at a rag and bone shop, to which kinetic energy was given by a falling weight, which, I remember, occupied the attention of four white-headed directors of electric companies in 1882 (evening students) for many weeks. A casual first measurement led on to corrections for friction and stiffness of a cord, and much else of a most interesting kind. At the end of six weeks these gentlemen had gained a most thorough computational acquaintance with every important principle of mechanics, a knowledge never to be forgotten. They had also had a revelation such as comes to the true experimenter—but that is too deep a subject.

Perhaps teachers in the greater colleges will smile in a superior way when they hear of this kind of experimental mechanics being called engineering laboratory work. True it was elementary mechanics; but is not every principle which every engineer constantly needs called a mere elementary principle of mechanics by superior persons? I find that these elementary principles are very much unknown to men who have passed through elaborate mathematical studies of mechanics. Students found out in that laboratory the worth of formulæ; they gained courage in making calculations from formulæ, for they had found out the extent of their own ignorance and knowledge.

At Finsbury there was an excellent one-cylinder engine with vaporizing condenser. It drove the workshops and electric generators. On a field day it drove an electric generator only, and perhaps thirty students made measurements. Each of them had already acted as stoker and engine-driver, as oiler and tester of the machinery, lighting fires, taking indicator diagrams, weighing coal, opening and closing cocks from seven in the morning to ten at night, so that everything was well known to him. They maintained three different steady loads for trials of three hours each. They divided into groups, one from each group ceasing to take a particular kind of observation every ten minutes and removing to another job. All watches were made to agree, and each student noted the time of each observation. These observations were: Taking indicator diagrams, checking the speed indicator, taking temperature of feed water, quantity of feed by meter (the meter had been carefully checked by gauge notch, and every other instrument used by us had been tested weeks before), taking the actual horse-power passing through a dynamometer coupling on the shaft, taking boiler and valve-chest pressures and vacuum pressures on the roof and in the engine room, weighing coal (the calorific value had already been tested), taking the horse-power given out by the dynamo, counting the electric lamps in use, and so on. Each student was well prepared beforehand. During the next week he reduced his own observations, and some of the results were gathered on one great table. One lesson that this taught could never be forgotten—how the energy of one pound of coal was disposed of. So much up the chimney or by radiation from boiler or steam jacket and pipes; in con-

densation in the cylinder; to the condenser; in engine friction; in shaft friction, etc. I can not imagine a more important lesson to a young engineer than this one taught through a common working engine. The students had the same sort of experience with a gas engine. I need hardly say how important it was that the professor himself should take charge of the whole work leading up to, during, and after such a field day.

The difficulty about all laboratory exercise work worth the name is that of finding demonstrations and assistants who are wise and energetic. Through foolishness and laziness the most beautiful system becomes an unmeaning routine, and the more smoothly it works the less educational it is. In England just now the curse of all education is the small amount of money available for the wages of teachers—just enough to attract mediocre men.

No kind of engineering has developed so rapidly as the electrical. Why, it was at the meeting here in Belfast twenty-eight years ago (I remember, for I was a secretary of section A that year, and took the machine to pieces afterward in Lord Kelvin's laboratory) that there was exhibited for the first time in these islands a small Gramme machine. This handmaid of all kinds of engineering is now so important that every young engineer may be called uneducated who has not had a training in that kind of mechanical engineering which is called electrical engineering. Thus it will be found that in every electrical engineering laboratory the elementary principles are made part of a pupil's mental machinery by many quantitative experiments, and nobody suggests that it is mere elementary physics which is being taught—a suggestion often enough made about the work in my mechanical laboratory. When students know these elementary principles well, they can apply their mathematics to the subject. As they advance in knowledge they are allowed to find out by their own experiments how their simple theories must be made more complex in real machines. Their study may be very complete, but, however much mathematics and geographical calculation may come in, their designs of electrical machinery are really based upon the knowledge acquired by them in the electrical and mechanical laboratories.

The electrical engineer has an enormous advantage over other engineers; everything lends itself to exact calculation, and a completed machine or any of its parts may be submitted to the most searching electrical and magnetic tests, since these tests, unlike those applied by other engineers, do not destroy the body tested. But for this very reason, as a finished product, the electrical engineer can not have that training in the exercise of his judgment in actual practical work after he leaves a college that some other engineers must have. In tunneling, earthwork and building, in making railways and canals, the engineer is supremely dependent on the natural conditions provided for him, and these conditions are never twice the same. There are no simple laws known to us about the way in which sea and river currents will act upon sand and gravel, and engineers who have had to do with such problems are continually appealing to Nature, continually making observations and bringing to bear upon their work all the knowledge and habits of thought that all their past experience has given them. I do not know that there is any job which a good teacher would have greater pleasure in undertaking than the arrangement of a laboratory in which students might study for themselves such problems as come before railway, canal, river, harbor and coast-protection engineers; there is no such laboratory in existence at the present time, and in any case it could only be of use in the way of mere suggestion to an engineer who had already a good knowledge of his profession.

Most of the students were preparing for electrical or mechanical engineering, and therefore we thought it important that nearly every professor or demonstrator or teacher should be an engineer. I know of nothing worse than that an engineering student should be taught mathematics or physics or chemistry by men who are ignorant of engineering, and yet nothing is more common in colleges of applied science. The usual courses are only suitable for men who are preparing to be mere mathematicians, or mere physicists, or mere chemists. Each subject is taken up in a stereotyped way, and it is thought quite natural that in one year a student shall have only a most elementary knowledge of what is to the teacher such a great subject. The young engineer never reaches the advanced parts which might be of use to him; he is not sufficiently grounded in general principles; his whole course is only a preliminary course to a more advanced one which there is no intention of allowing him to pursue, and, not being quite a fool, he soon sees how useless the thing is to him. The professor of chemistry ought to know that until a young engineer can calculate exactly by means of a principle, that principle is really unknown to him. For example, take the equation supposed to be known so well—

$$2H_2 + O_2 = 2H_2O.$$

It is never understood by the ordinary elementary chemical student who writes it down so readily. Every one of the six cunning ways in which that equation conveys information ought to be as familiar to the young engineer as they are, or ought to be, to the most specialized chemist. Without this he can not compute in connection with combustion in gas and oil engines and in furnaces. But I have no time to dwell on the importance of this kind of exact knowledge in the education of an engineer.

Mathematics and physics and chemistry are usually taught in water-tight compartments, as if they had no connection with one another. In an engineering college this is particularly bad. Every subject ought to be taught through illustrations from the professional work in which a student is to be engaged. An engineer has been wasting his time if he is able to answer the questions of an ordinary examination paper in chemistry or pure mathematics. The usual mathematical teacher thinks most of those very parts of mathematics which to an ordinary man who wants to use mathematics are quite valueless, and those parts which would be altogether useful and easy enough to understand he never reaches, and, as I have said, so it is also in chemistry. Luckily, the physics professor has usually some small knowledge of engineering; at all events he respects it. When the pure mathematician is compelled to leave the logical sequence which he loves to teach mechanics, he is apt scornfully to do what gives him least trouble, namely, to give as "mechanics" that disguised pure mathematics which forms ninety per cent of the pretence of theory to be found in so many French and German books on machinery. As pure mathematical exercise work it is even meaner than the stupid exercises in school algebras; as pretended engineering it does much harm because a student does not find out its futility until after he has gone through it, and his enthusiasm for mathematics applied to engineering problems is permanently hurt. But how is a poor mathematical professor who dislikes engineering feeling like Pegasus harnessed to a common wagon—how is he to distinguish good from evil? He fails to see how worthless are some of the books on "theoretical mechanics," written by mathematical coaches to enable students to pass examinations. An engineer teaching mathematics would avoid all futilities; he would base his reasoning on that experimental knowledge already possessed by a student; he would know that the finished engineer can not hope to remember anything except a few general principles, but that he ought to be able to apply these, clumsily or not, to the solution of any problem whatsoever. Of course he would encourage some of his pupils to take up Thomson and Tait, or Rayleigh's "sound," or some other classical treatise as an advanced study.

Not only do I think that every teacher in an engineering college ought to have some acquaintance with engineering, but it seems to me equally important to allow a professor of engineering, who ought, above all things, to be a practical engineer, to keep in touch with his profession. A man who is not competing with other engineers in practical work very quickly becomes antiquated in his knowledge; the designing work in his drawing office is altogether out of date; he lectures about old difficulties which are troubles no longer; his pupils have no enthusiasm in their work because it is merely academic and lifeless; even when he is a man distinguished for important work in the past his students have that kind of disrespect for his teaching which makes it useless to them. If there is fear that

too much well-paid professional work will prevent efficiency in teaching, there is no great difficulty in applying a remedy.

One most important fact to be borne in mind is that efficient teachers can not be obtained at such poor salaries as are now given. An efficient laborer is worthy of his hire; an inefficient laborer is not worthy of any hire, however small. Again, there is a necessity for three times as many teachers as are usually provided in England. The average man is in future to be really educated. This means very much more personal attention, and from thoughtful teachers.

Advocacy of teaching of the kind that was given at Finsbury is often met by the opposition, not only of pure mathematicians and academic teachers, but I am sorry to say also of engineers. The average engineer not merely looks askance at, he is really opposed to the college training of engineers, and I think, on the whole, that he has much justification for his views. University degrees in engineering science are often conferred upon students who follow an academic course, in which they learn little except how to pass examinations. The graduate of to-day, even, does not often possess the three powers to which I have referred. He is not fond of reading, and therefore he has no imagination, and the idea of an engineer without imagination is as absurd as Teufelsdröch's notion of a cast-iron king. He can not really compute, in spite of all his mathematics, and he is absurdly innocent of the methods of the true student of Nature. This kind of labeled scientific engineer is being manufactured now in bulk because there is a money value attached to a degree. He is not an engineer in any sense of the word, and does not care for engineering, but he sometimes gets employment in technical colleges. He is said to teach when he is really only impressing upon deluded pupils the importance of formulæ, and that whatever is printed in books must be true. The real young engineer, caught in this eddy, will no doubt find his way out of it, for the healthy experience of the workshop will bring back his common sense. For the average pupil of such graduates there is no help. If he enters works, he knows but little more than if he had gone direct from school. He is still without the three qualifications which are absolutely necessary for a young engineer. He is fairly certain to be a nuisance in the works and to try another profession at the end of his pupilage. But if it is his father's business he can make a show of knowing something about it, and he is usually called an engineer.

Standardization in an industry usually means easier and cheaper and better manufacture, and a certain amount of it must be good even in engineering, but when we see a great deal of it we know that in that industry the true engineer is disliked. I consider that in the scholastic industry there has been far too much standardization. Gymnasien and polytechnic systems are standardized in Germany, and there is a tendency to import them into England; but in my opinion we are very far indeed from knowing any system which deserves to be standardized, and the worst we can copy is what we find now in Germany and Switzerland. What we must strive for is the discovery of a British system suiting the British boy and man. And if it were possible to make the average English boy of nineteen pass such a silly school-leaving examination as the German boy, and to pass through a polytechnic, I am quite sure that there would be little employment among common-sense English engineers for such a manufactured article. But is it possible that British boys could be manufactured into such obedient academic machines, without initiative or invention or individuality, by teachers who are none of them engineers? No, we must have a British system of education. We can not go on much longer as we have done in the past without engineering education, and, furthermore, it must be such as to commend itself to employers. Of my Finsbury students I think I may say that not one failed to get into works on a two or three years' engagement, receiving some very small wage from the beginning and without paying a premium. To obtain such employment was obviously one test of fitness to be an engineer, because experienced men thought it impossible. One test of the system was the greater ease with which new men obtained employment in shops which had already taken some of our students. It is certainly very difficult to convince an employer that a college man will not be a nuisance in the shops.

To have any good general system the employers must cooperate. Much of the training is workshop practice, and it can not be too often said that this is not to be given in any college. The workshop in a college serves a quite different purpose. Now, how may the practice best be given? When I attended this college in winter I was allowed to work in the Lagan foundry in summer. In Japan the advanced students did the same thing; they had their winter courses at the college, and the summer was spent in the large government workshops; the system worked very well indeed. In Germany, recently, the great unions of manufacturers made facilities for giving a year of real factory work to the polytechnic students, but it seems to me that these men are much too old for entrance to works, and, besides, a year is too short a time if the finished product is to call itself a real engineer. Possibly the British solution may be quite different from any of these. A boy may enter works at fourteen on leaving a primary school, or not later than sixteen on leaving a secondary school. In either case he must have the three powers to which I have already referred so often. It will be recognized as the duty of the owners of works to provide, either in one large works or near several works, in a well-equipped school following the Finsbury principle, all the training in the principles underlying the trade or profession which is necessary for the engineer. And now I want to call your attention to a new phenomenon. Over and over again has attention been called to the fact that the engineer has created what is called "modern civilization," has given luxuries of all kinds to the poorest people, has provided engines to do all the slave labor of the world, has given leisure and freedom from drudgery, and chances of refinement and high thought and high emotion to thousands instead of units. But it is doing things more striking still. Probably the most important of all things is that the yoke of superstitions of all kinds on the souls of men should be lifted. The study of natural science is alone able to do this, but education through natural science for the great mass of the people, even for the select few, called the distinguishd men of the country, has been quite impossible till recently. I say that it is to engineers that the world owes the possibility of this new study becoming general. In our country nearly all discoveries come from below. The leaders of science, the inventors, receive from a thousand obscure sources the germs of their great discoveries and inventions. When every unit of the population is familiar with scientific ideas, our leaders will not only be more numerous, but they will be individually greater. And it is we, and not the schoolmasters, who are familiarizing the people with a better knowledge of Nature. When men can hardly take a step without seeing steam engines, and electromotors, and telegraphs, and telephones, and steamships, with drainage and waterworks, with railways and electric tramways and motor cars; when every shop window is filled with the products of engineering enterprise, it is getting rather difficult for people to have any belief in evil spirits and witchcraft.

All the heart-breaking preaching of enthusiasts in education would produce very little effect upon an old society like that of England if it were not for the engineer. He has produced peace. He is turning the brown desert lands of the earth into green pastures. He is producing that intense competition among nations which compels education. If England has always been the last to begin reform, she has always been the most thorough and steadfast of the nations on any reform when once she has started on it. Education, pedagogy, is a progressive science; and who am I that I should say that the system of education advocated by me is that which will be found best for England? In the school education of the average boy or man, England has as yet had practically no experience, for she has given no real thought to it. Yet when she does, I feel that although the Finsbury scheme for engineers may need great improvement, it contains the germ of that system which must be adopted by a race which has always learned through trial and error, which has been led less by abstract principles or abstract methods of reasoning than any race known in history.

Machine Tool Progress—II.

By Charles E. Hadley.

THE first application of the turret that I remember was the ingenious devices made for the United States Government by the Ames Manufacturing Company for operations on gun stocks. They were wood-working machines, but had the elements of the present iron-working turret. The barrel-bedding machine had a rack of vertical spindles, successively moved by hand into operative position.

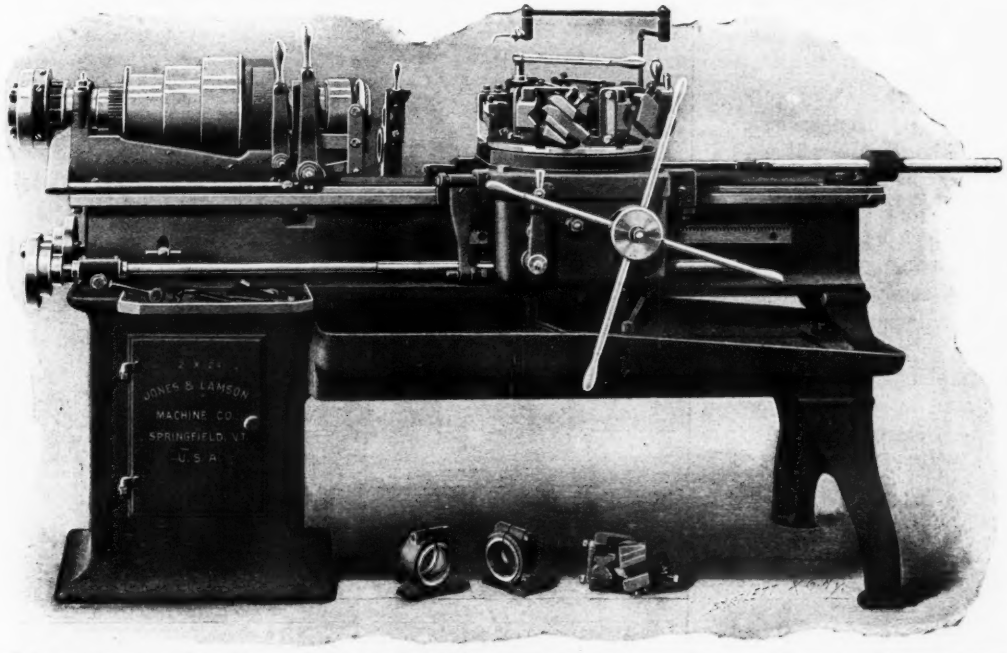
In the lock-bedding machine this rack of spindles was arranged in a circle which was ratcheted successively into working position, each spindle provided with a tool for its special cut. Then came the grouping of tool-holding spindles, resembling a gatling gun in appearance as much as anything, in which the spindles were brought into line with a ratchet and the sliding spindles were propelled to their work by means of a rack reciprocating in what might be called a tail stock. This device worked very well, and the application of power was direct and scientific, but there was no room for large tools, and this construction soon gave place to the vertical turret which we use so generally to-day.

Applied to a lathe or as a part of a chucking machine it has immensely facilitated short turning operations where duplication of parts is the question.

Economical, not only on account of convenience in handling by virtue of the facility with which the different tools are brought into action, but also on account of proper distribution of cut as a stock-removing factor the turret changed a lathe into a manufacturing tool with a jump at last.

The complete screw machine, the most distant relation of the lathe, is the best adapted to duplication of parts and the least useful for general work. Its hollow spindle spring chuck and wire feed, its bed devoted solely to the support of a turret, a head and a practically fixed cross-slide, which is the style of the lighter machines, make of it a highly specialized design, which has done more, perhaps, than any other tool to account for the enormous difference in price between mechanical products regularly catalogued and the cost of a single piece of special construction. The first screw machines were of small size. The name is significant—screw machine, machine for making screws; the term wire feed also suggests the small size of the stock operated upon. Sounds a little odd now to define the mechanism that controls the movement of a four-inch bar of round steel as a wire feed; but the reason is obvious—force of habit. The screw machine grew almost too large in some cases to be handled like smaller machines, power feed was applied to the turret, a carriage was inserted between that important member and the head, and while these additions were being made to the heavier machines the smaller ones were being used as the foundation of the automatic machine. And this was one of the cleanest and most practical of metamorphoses; the leg patterns were changed, a horizontal shaft was adapted to carry ordinary pulleys upon whose peripheries were screwed the cams for controlling the spring chuck and wire feed, the cross-slide and the turret, all done almost without a change in the original machine.

We are indebted to the Pratt & Whitney Company and the Hartford Machine Screw Company for the pioneer work in this line.



Front View, Two by Four Flat Turret Lathe, Made by Jones & Lamson Machine Company, Springfield, Vt.

Each machine adapted, as it is, to produce the same character of work as the other, has its distinct field.

The regular machine applies where the plant is small or where the screw machine work of a large plant is a small proportion of the whole. An active man, when he is on piecework especially, can beat the automatic, then again changes of work can be set up far more readily. But as a good man, on the other hand, can keep a dozen or more automatics running, it is easy to see which machine is preferable where uniformity and quantity of product are the factors.

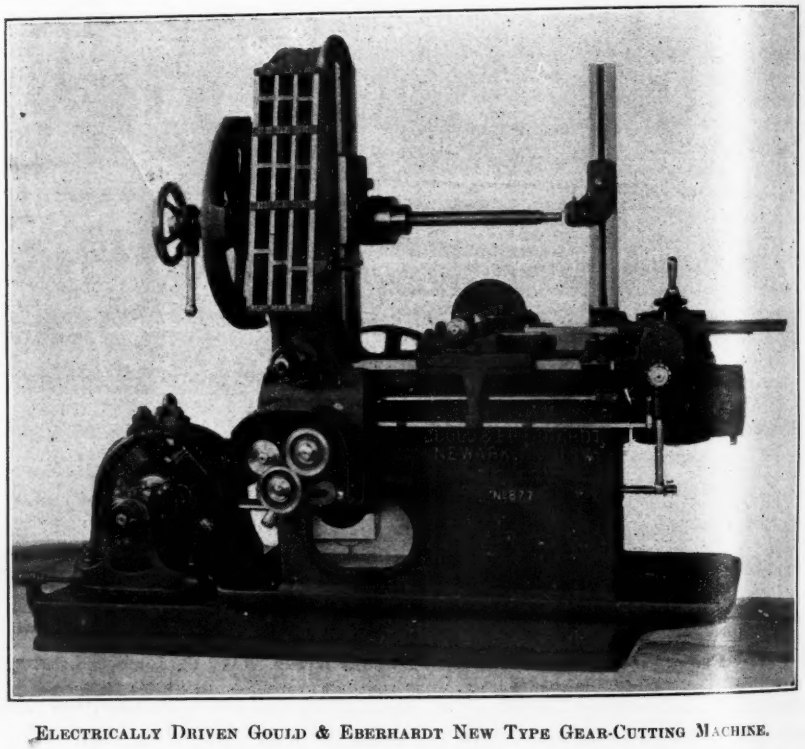
Thus we have at one end of the line the

engine lathe and at the other the automatic screw machine, and good mechanics have been trying, with latterly good results, to unite as far as possible the adaptability of the lathe and the high economy of the screw machine, and the result is the flat turret lathe of Jones & Lamson and the turret machines of the Garvin Machine Company and the American Turret Lathe Company. This development has resulted largely from the modification of turret tools, which include, in the full equipment, universal die-holders and tool-holders. Formerly each die meant a separate turret tool, each turning size a box tool whose depth was always limited as against a combination tool, in whose length of twenty inches turning tools of any shape are as easily set as lathe tools can be placed at any longitudinal spacing desired.

In these machines the turret is provided with regular lathe feeds, and so designed as to allow a long piece of work to pass entirely through it. Here we have a type of screw machine that it will pay to set up for a few pieces of a kind. Times have changed since the day that Chordal's negro engineer was discovered boring out a cylinder with a grate bar.

As a comparatively few years were required to evolve the automatic screw machine from the lathe, so was the perfected milling machine a rapidly growing sprout from the planer. As in the lathe, the principle has never changed, so in the planer it is practically the same. Immensely increased in weight, these are of practically the same form as in the early days of the tool. The screw has been largely replaced by the rack for propelling the table, but there are still a great number of screw planers doing good service, and a very good modern example of the type is the Sellers planer, in which the table is driven by a worm and rack device, which is a modification of the screw.

The planer went through the same course of growth and improvement as the lathe, until it came to the question of distribution of cut and convenience of handling, and then form changed entirely and the Lincoln miller appeared, which design was appreciatively adopted by many tool builders, and produced in great numbers up to the present day. It is a popular type for straightaway cuts—stiff, inexpensive, rigid by virtue of its substantial tail support and easily adjustable to compensate for diminishing diameter of cutter due to grinding. Its best work is done, however, on surface cuts, and the call for a machine which the workman could get around three sides of inspired the knee type of machine, and this bears the relation to the Lincoln type which the shaper bears to the planer. Strangely enough, one of the first knee machines was a Universal and is produced in large numbers by its manufacturers, Brown & Sharpe, who for seventeen years had a monopoly of the swivel base which, with the dividing head, forms the distinguishing feature of the Universal machine. Many modifications of the knee machine are now in the market, more or less adapted to special requirements. The range of the Universal machine has been widened by the continual addition of convenient devices, such as rack-cutting attachments, auxiliary high-speed spindles—spindles disposed vertically—swivel vises, automatic feeds in every direction, spring chucks, until the number of parts arrayed around the machine in the trade cuts, as legitimate parts of the machine's regular equipment, make quite a machine shop in themselves.

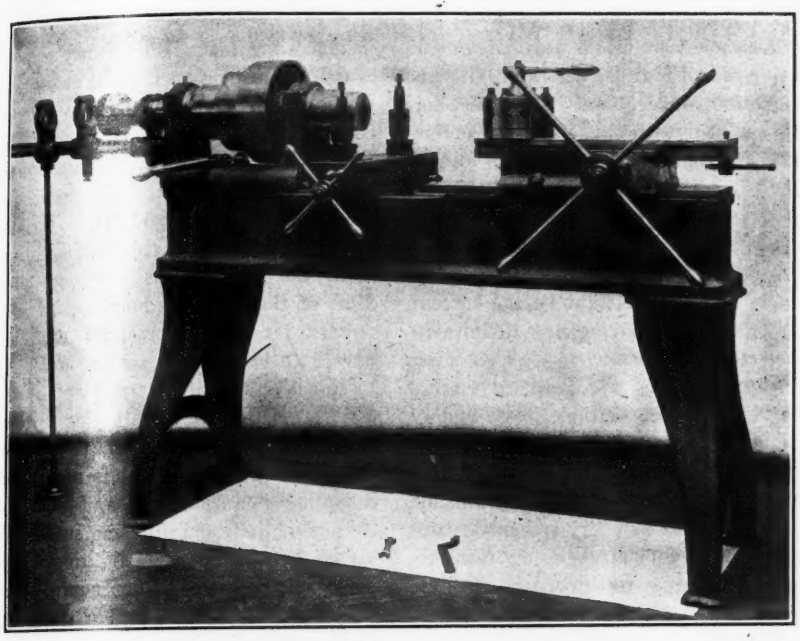


Electrically Driven Gould & Eberhardt New Type Gear-Cutting Machine.

The Midland Electric Power Distribution.

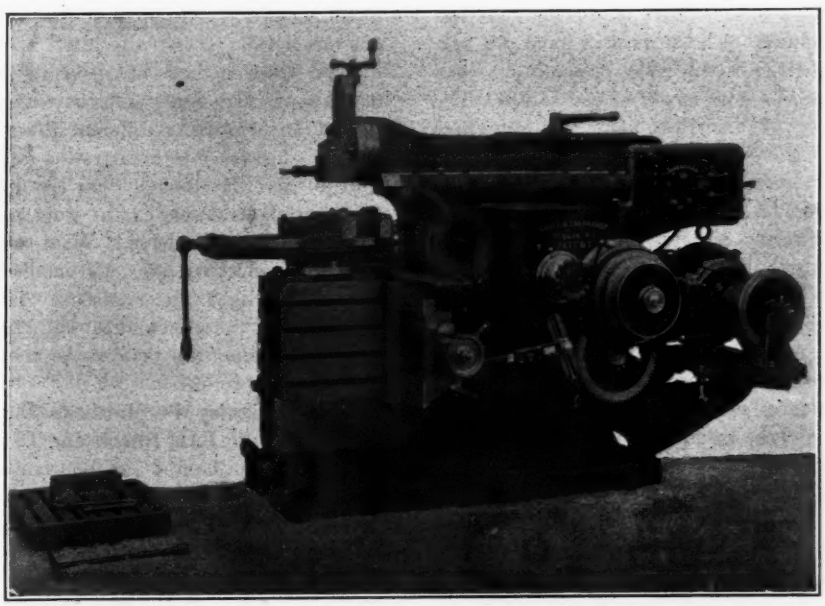
The ideal system of economical power distribution, when the engineer is dependent upon coal for furnishing the energy in the first instance, is to have the power station at the pit's mouth, and supply a district forming a circle, whose centre is the power-house. This condition will be almost fulfilled in the case of the Midland Electric Corporation for power distribution, says the London *Electrician*. The district which the company has acquired for its operations forms roughly a semi-circle, with the power-house at its centre, and contains, in addition to a network of tramways which takes its current from the company, numerous works which should before long abandon their present steam driving in favor of electric driving. The radius over which the company supplies is about seven miles, which may fairly be taken as the maximum over which underground electric power would be economical in view of the cheapness of coal over the district. The generating station is conveniently located on the Birmingham Navigation Company's canal, from which a small basin has been diverted for the purpose of loading and unloading barges directly to the coal conveyor. This is a Hunt chain conveyor, with a coal and ash elevator. Coal is loaded directly from the barge by a skip, which is elevated by a two-phase motor and automatically tipped into a large hopper, from whence it is carried to the bunkers over the top of the boilers. The boiler house at present includes eight Babcock & Wilcox boilers, arranged in pairs, each boiler having an evaporative capacity of 12,000 pounds of water from and at 212 degrees Fahrenheit. The boilers are fitted with Babcock & Wilcox chain grate stokers and superheaters. The chimney is 120 feet high and nine feet six inches inside diameter, with fire-

brick lining. Provision is made for fans to produce induced draught when this shall be needed. The engine room contains two 800-kilowatt alternators and one 1,500-kilowatt alternator. Space is



A New Combination Turret Lathe, Made by the Garvin Machine Company, New York.

reserved for two more of the larger size, and sufficient land is reserved to lengthen the engine room three or four times. The alternators generate two-phase current directly at 7,000 volts. All three are Ferrati's make, the two smaller ones being driven by a Ferrati engine, the larger by a Yates & Tom engine. Both engines are of the vertical cross-compound type, the Ferrati engine running at 166 revolutions per minute and the Yates & Tom at ninety revolutions per minute. The dynamos differ but slightly in general design from the standard Ferrati. The armatures are tunnel wound, the windings being cotton covered and placed in micanite tubes. The magnets have cast-steel pole-shoes, and the magnet coils are wound with insulated copper strip on edge. A frequency of fifty cycles per second has been adopted. Each unit is capable of working continuously at twenty-five per cent overload, with a power-factor of 0.8. At present the plant is running non-condensing, and independent surface condensers having 20,000 square feet of cooling surface have been provided for each engine. The switchboard embodies the latest practice in high-voltage systems. The switch gear includes oil-brake switches of entirely new design and a modification of the Ferrati oil-brake fuse. The switches operate on the divided break system. The main contact outside of the oil chamber breaks contact first. The final break is in shunt with this and takes place at seven blades within an oil vessel, each of the blades joining with a corresponding tip contact fixed to the interior of the vessel, constituting, as it were, a double break, so that a spark is divided among fourteen breaks in series, and all under oil. The switch is operated by a spring. In switching on there is a synchronizing contact at half cock. The box containing the oil and shunt blade is of porcelain and quite covered in. These switches have a maximum capacity of 1,000 kilowatts, and are intended for alternating-current pressure between 7,000 and 15,000 volts. The fuses have four breaks in parallel, the fuse wires in each case being bridged over the top of a pair of upright porcelain tubes. The main body of the apparatus is made up of a porcelain holder provided with a handle at the front for removing and replacing the fuse. Into this holder a gun-metal fitting is cemented, containing the necessary contacts for operating the fuse. When in position, the porcelain tubes just touch one another at the top, and across these joints the fuse wires are stretched and soldered to the ends of a flexible copper strip. These strips, when drawn out to their full extent, wind up springs on the barrel of the spindle, and as soon as the fuse melts each strip is quickly pulled down into the oil with which both tubes and porcelain box are filled. When it is required to replace the fuse while in operation, a short-circuiting device can be fitted above the fuse itself. The two phases of the plant are quite independent on each dynamo. A pair of lead-covered concentric cables lead up from each machine to the switchboard, rising vertically from below. The construction of the switchboard is very substantial. The framework of the board is divided into compartments into which the switches are run, making contact with clips. These fuses are also enclosed in separate insulating contacts, which prevents the passage of any arc between the contact jaws themselves. There are two switchboards in addition to the main board—one for the meters and the other for local distributing circuits. Details of the extra high-pressure oil-brake switch and oil-brake fuse are shown.



Double Triple-Stroke Extension Base Shaper, Made by Gould & Eberhardt, Newark, N. J., Electrically Driven.

Photometry and Illumination.

Papers and Discussion at the One Hundred and Sixty-Ninth Meeting of the American Institute of Electrical Engineers.

THE regular monthly meeting of the American Institute of Electrical Engineers was held in New York city, Friday evening, October 24. The secretary announced the election of thirty-five associates.

Mr. T. C. Martin, chairman of the John Fritz medal committee, reported what had been accomplished at the recent meeting of that committee. This medal is to be awarded for original and meritorious work of a technical nature, the idea having had its inception last year. The sympathy with which this has been received has been very encouraging. At the meeting of the committee, the progress which had been made was gone over, and it was found that sufficient money had been subscribed to assure the success of the undertaking. Mr. Fritz, who is the oldest iron master in this country, is now in his eightieth year, and this is to be signalized by the foundation of this medal and by a John Fritz medal banquet, to be held at the Waldorf-Astoria, New York city, October 31. Much satisfaction was felt from the fact that $6,000 had been subscribed to this by electrical engineers. The amount in hand was sufficient to assure the presentation each year of a gold medal valued at $100. The award of this will be made by a committee formed of four members of each of the four engineering societies—the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the American Institute of Mining Engineers and the American Society of Civil Engineers. The committee from the American Institute of Electrical Engineers will consist of the president and the three preceding presidents. For this year these members will be Mr. Charles F. Scott, Mr. Charles P. Steinmetz, Mr. Carl Hering and Dr. A. E. Kennelly. This is the first time that these engineering societies have acted together, and this in itself is a matter for congratulation. Mr. Martin expressed the wish not only to see this medal awarded to an electrical engineer in the near future, but he hoped that similar medals would be established by the Institute.

The subject for the evening—"Photometry and Illumination"—was then briefly introduced by President Scott. No attempts at improving the means of illumination were made until about 100 years ago. Progress was slow and the illuminants inadequate. Our ancestors were satisfied with candles and, more recently, oil lamps and gas. The electric light has been introduced only within the last twenty-five years.

Our means of measuring light are most unsatisfactory. We sell gas by the volume and electric light by the current, neither quantity having any definite relation to the amount of light secured. This unfortunate condition is emphasized by the fact that electrical energy, although so intangible, is measured most accurately, and the standards are excellent. Measurements of light are difficult, inaccurate, unsatisfactory and inadequate, the principal difficulty arising from the fact that light is recognized by a physiological effect and can be determined by no physical measurements. When the late Professor Henry A. Rowland was asked what would be the best method of determining the suitability of the alternating-current arc lamp, he said: "Let an old lady try to read by it and see if it hurts her eyes." Although at first this seems unscientific, it is really based upon the only true method of determining illumination. Mr. Scott emphasized the fact that, in comparing different illuminants, it is necessary to measure the total output of each. He thought that the diffusion and distribution curves were not what should be considered. What was wanted was effectiveness. All methods of producing light are wasteful. The distribution is unsatisfactory, and the only correct comparison that can be made is the effect.

Professor Charles P. Matthews then read his paper on "An Integrating Photometer for Glow Lamps and Sources of Like Intensity." This was well received, and created a great deal of interest and praise. The paper appears in full in other columns of this issue.

This was followed by Mr. Douglass Burnett's paper on "Distributed Lighting." Mr. Burnett said in part that papers already presented to the Institute on this subject had attracted attention to the possibility of reducing the general considerations which they propound to a more scientific and exact basis than has yet appeared. Commercially speaking, instances are few where the raw material is the finished product. The necessity of manipulating sources of light to practical ends has been realized for many centuries. Photometric studies have been concerned with sources of light, their production, comparison and standardization, their intensity, quality and characteristics, and with the instruments for measuring. Most of the work has been carried on in rooms, for which practical conditions have been excluded. Attention was called to the necessity of determining the conditions existing at illuminating surfaces, and not those existing at the primary source of light. No light is useful until it impinges on something, and distributed sources of light and diffusing surfaces are always present in actual lighting. Light from our common illuminants should always be distributed, and a number of methods are being used to-day in which the light itself is concealed, the light being diffused and reflected from other bodies. The author then considered the distribution of light as effected by reflection and radiation, and thought it was possible in some measure to calculate this quantity along an illuminated surface. A fundamental law in this connection is that illumination from independent sources may be arithmetically added to determine the resultant illumination. The author thought that it was not correct to plot the intensity curves of the lamp, as the impression they conveyed was false. He thought that the curves to be plotted were those along which the lighting is equal at any point. These curves he called "isophotals." Curves of this character have been published by Weber. There were a number of photometers suitable for measuring the intensity of the illumination on a surface. The author then described his instrument which had been designed for measurements of this kind, and stated the precautions necessary in its use. It is thought that hereafter practical requirements can be more clearly specified by the assistance of some such instrument.

Mr. John T. Marshall then described "The Evolution of the Sliding Scale Photometer," which is now being used at a number of lamp factories, the advantages of the photometer lying in the fact that no electrical measuring instruments are

required, and one reading is sufficient to determine the proper voltage of any lamp.

Dr. Clayton H. Sharp then presented a paper upon "The Commercial Accuracy of Photometrical Measurements." The term "practical accuracy" was first considered, and it was shown that ordinarily an accuracy of two per cent was sufficient in practical work, and the purpose of this paper was to enquire whether photometrical measurements conformed in general to the requirements of commercial accuracy. There seems to be a widespread feeling that such is not the case. It is undoubtedly true that a certain amount of skill and practice is required to make good photometrical measurements, and that certain precautions must be taken, the neglect of which will vitiate such measurements, and it is the business of a photometrist to have such skill and to be familiar with such precautions. The fact that bad photometrical measurements have been made does not argue that this class of measurements is of itself unreliable. Photometrical measurements are divided into three general classes—First, those in which the primary or unit of luminous intensity is used to calibrate secondary standards of the same. The results of these measurements are involved in the uncertainty connected with the production of the primary standards. The second class of measurements comprises the calibration of working standards by reference to the original secondary standards. This is a class of work which can be carried out to the highest degree of accuracy. The third class includes commercial measurements of sources of light by reference to working standards, and here speed is an important factor. To ascertain if a good commercial accuracy is obtainable, a series of experiments was carried out in the lamp testing bureau. The results of these experiments are given, and it is shown that accurate work can be done, and that the error need not be greater than the allowable two per cent. The author summarized his paper as follows: Primary standards of luminous intensity, whatever may be their shortcomings from the point of the physicist, are sufficiently accurate for commercial purposes. These standards can be copied to as high a degree of accuracy as is desired. Rapid photometrical measurements can be made with all the accuracy required for commercial purposes. In the case in which the photometrical measurements are in the worst repute; namely, in the photometry of the arc, the chief fault lies in the varying nature of the quantity which it is sought to measure, rather than with available methods of measuring the same.

The discussion was opened by Dr. E. L. Nichols, of Cornell University, who emphasized the value of Professor Matthews's instrument, which enabled the mean spherical candle-power to be determined by one measurement. Lamps should be rated by their mean spherical candle-power, but previous methods of determining this quantity were so laborious that it has become customary to require only the mean horizontal candle-power. Dr. Nichols then called attention to the importance of studying illumination rather than intensity and described a room which had been set aside at Cornell for this purpose. In this room lights can be distributed in any manner desired, the covering of the wall can be changed at pleasure, and the illumination at various parts of the room determined by measurements made at these points. In this work, the Weber photometer had been used.

Mr. L. B. Marks showed that the Institute consistently recommended the use of the mean spherical candle-power in rating lamps, and that the National Electric Light Association had admitted the value of this rating, but, since its determination was tedious, had agreed upon the mean horizontal candle-power as a satisfactory rating. The speaker pointed out that the objection which might be made to the mean spherical rating was that the public would not be satisfied, as lamps rated in this way have a smaller output. He thought that this difficulty could be met by rating the lamp in some other way. The present rating of a sixteen-candle-power lamp is entirely arbitrary, and some other unit could be substituted. The same objection has been made to the enclosed arc lamp, and it has taken three years to overcome it. Mr. Marks did not think there could be any doubt but what the mean spherical rating must also be taken, in view of the fact that large companies are at the present time requiring this rating in their specifications. He warmly praised the instrument constructed by Professor Matthews, and thought that its use in determining the value of new forms of illuminants would be very great. The means adopted by Professor Matthews for correcting the inequalities of the cosine law and inequalities in the mirrors was very pretty and ingenious.

Mr. W. S. Howell then stated that the lamp testing bureau had tested this instrument and had decided to use it.

Mr. F. S. Smith thought that lamp makers, as well as lamp users, were indebted to Professor Matthews for his valuable instrument.

Dr. E. B. Rosa stated that the National Bureau of Standards had not as yet taken up photometrical work, but they hoped to do so as soon as the buildings were completed, when the question of standards would be carefully studied.

Mr. Calvin W. Rice expressed his appreciation of the instrument and emphasized the fact that our present primary standards are unsatisfactory, and that better ones are needed. He presented a brief communication from Mr. A. J. Wurts, suggesting a room photometer such as had already been described by Professor Nichols, as, in the author's opinion, this would furnish the only satisfactory method of determining illumination.

Mr. W. J. Hammer suggested the use of selenium cells in work of this character.

Professor Matthews expressed special satisfaction with Dr. Sharp's paper, and stated that photometrical measurements were not necessarily inaccurate, but that much depended upon the skill of the observer.

The discussion was participated in by Dr. S. W. Stratton, Mr. Luther Stieringer, Professor H. J. Ryan and President Scott.

AN INTEGRATING PHOTOMETER FOR GLOW LAMPS AND SOURCES OF LIKE INTENSITY.

BY CHARLES P. MATTHEWS.

In a previous paper*, I have described an equipment designed for the photometric study of arc lamps. The most valuable feature of this equipment lies in its ability to yield a value of the mean spherical luminous intensity from a single photometer setting. It is the purpose of this paper to describe an apparatus possessing this same valuable feature, and several others worthy of note, when used for the photometry of the incandescent lamp and other sources of the same order of brightness.

Designed especially for incandescent lamp measurements, the apparatus has several functions and might have been styled a "universal glow lamp photometer." It is capable of use for all photometric measurements on the glow lamp that do not lie in the province of spectro-photometry. To particularize, it may be used as follows:

First—As a simple photometer for any

* "Transactions," xviii, 1901.

unidirectional measurements, such as occur in standardizations, ratings and candle-power distributions.

Second—As an integrating instrument for the direct determination of mean horizontal, mean spherical, mean hemispherical or mean zonular candle-power.

Third—As an integrating instrument for the direct determination of the spherical reduction factor; that is, the ratio—mean; mean horizontal candle-power.

THE IMPORTANCE OF THE MEAN SPHERICAL VALUE.

The fact has long been recognized* that the only strictly fair basis for the comparison of incandescent lamps is that of the total flux of light emitted, a quantity proportional to the mean spherical candle-power. It is possible by altering the configuration of the filament to concentrate luminous flux in particular solid angles at the expense of flux in other angles. Hence, two lamps of equal rated candle-power may yield total light flux in quite different amounts. On the other hand, if two lamps have initially the same mean spherical candle-power, their relative value is determined simply by their power consumption and sustained candle-power. The vexed question of what is the most useful light may well be left to the purchaser, who can select the type of filament best adapted to his own needs. The question is comparable to that which asks, What is the best diet for man?

EXISTING METHODS FOR THE DETERMINATION OF THE MEAN SPHERICAL VALUE.

Of the methods in use in the determination of the mean spherical candle-power, the most accurate is that in which measurements are made at equal angular intervals through 180 degrees in a plane passing through the axis of symmetry of the filament, the lamp being rotated meanwhile about this axis. From the readings so obtained, the mean spherical value may be found either by formula or the graphical construction known as the Rousseau diagram.†

The method employed in the Franklin Institute tests of 1884 involves the mean of thirty-eight candle-power values taken in such directions as to give a nearly uniform space distribution. The mean of these values is the result sought.

Both of the foregoing methods involve a large number of readings—so large, in fact, that their application to the practical rating or extended study of lamps is out of the question.

A third method consists in the use of the spherical reduction factor appropriate to the type of filament under consideration. Unfortunately, this factor is not a constant for any given type of lamp. With some types, the method yields a good result; with others the variations are such as to render the results only roughly approximate. A disadvantage is the large and increasing number of types on the market and the necessity for determining and keeping account of the corresponding constants.

Liebenthal found as the result of an extended series of measurements that the mean of the intensities taken at 51.8 degrees north polar distance and 51.8 degrees south polar distance on a spinning lamp is

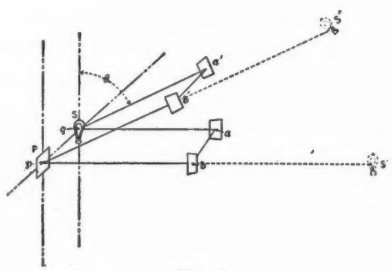


FIG 1.

a value approximating the mean spherical intensity regardless of the type of lamp. The errors resulting from the application of this method range from—0.1 per cent to + 3.9 per cent. This is probably the most accurate of the simpler approximative methods.

THEORY AND DESCRIPTION OF THE APPARATUS.

From what has been said, it would appear that there is need of a photometer capable of giving the mean spherical candle-power of an incandescent lamp with the ease and celerity obtainable in the ordinary photometric measurement. With this need in mind, I have designed and had constructed the apparatus described below.

The theoretical basis of the design is the approximate equation for the mean spherical intensity

$$I_{ms} = \frac{\pi}{2n} \sum_0^{\pi} I_\theta \sin \theta \qquad (1)$$

wherein I_θ is the intensity of a ray making an angle θ with a vertical passing through the light centre and n the number of terms in the summation. In order tnat equation (1) may apply to a glow lamp, it is necessary to spin the lamp precisely as is commonly done in determining mean horizontal candle-power.

To see how equation (1) may be made the basis of an integrating photometer, let us consider a source of lights (Fig. 1), and a photometer screen P whose plane extended contains the effective light centre of S. We will hereafter denote the centre of the photometer screen by p and the effective light centre by q. For convenience we will further assume that p and q lie in the same horizontal plane to which the plane of P is normal, and we will call the line $p\ q$ the axis of the system. Now consider two mirrors whose planes are vertical and make an angle of ninety degrees with each other. Let the centre of these mirrors, designated by a and b, come into the horizontal plane in such positions that the lines $q\ a$ and $p\ b$ are equal and respectively normal to the axis of the system. Let a' and b' be the centres of a second pair of mirrors occupying a position such as would be found by swinging a and b, without mutual displacement, upward about $q\ p$ as an axis until $q\ a$ makes the acute angle θ with the vertical. Having thus located a' and b' angularly, we may now assume that some radial movement of this pair of mirrors is possible. The eye placed at p will see virtual images of the source in horizontal and θ aspects respectively. The images s' and s'' may be regarded as producing jointly an illumination on the photometer screen of

$$i_0 + i_\theta = \frac{K_0 I_0}{d^2_0} + \frac{CK_\theta I_\theta}{d^2_\theta} \qquad (2)$$

where K_0 and K_θ are the reflection coefficients of the pairs of mirrors, d_0, d_θ, the distances from source to screen by way of the mirrors, and C a factor varying with the incidence of the light upon the photometer screen P. Now, if n pairs of mirrors be placed similarly to a, b and a', b', but spaced at equal angular intervals of $\Delta\ \theta$ such that $n\ \Delta\ \theta = \pi$, we shall have as the resulting illumination

$$\sum_0^{\pi} (i) = \sum_0^{\pi} \frac{CK_\theta\ I_\theta}{d^2_\theta} \qquad (3)$$

If by radial adjustment of the mirror pairs we make

$$\frac{CK_\theta}{d^2_\theta} = \frac{K_0 \sin\ \theta}{d^2_\theta} \qquad (4)$$

then

$$\sum_0^{\pi} (i) = \frac{K_0}{d^2_0} \sum_0^{\pi} I \sin \theta \qquad (5)$$

That is to say, the total illumination

*In 1897 a committee of the Institute reported as follows: ("Transactions," page 90.) "Although incandescent lamps are at present rated by their horizontal candle-power, yet since the only true criterion of the total quantity of light emitted by a lamp is its mean spherical candle-power, we recommend that the rating of lamps should be based upon their mean spherical candle-power so far as is commercially practicable."

† "Transactions," September, 1901.

of the screen is proportional to the mean spherical intensity of the source. (See equation 1.) To evaluate this intensity, it is necessary merely to balance this illumination against that due to a source of known intensity at a known distance.

Fig. 2 shows the disposition of twelve pairs of mirrors, m_1, m_2, etc., in order to produce the desired results. If the illumination of a given surface varied exactly as the cosine of the incidence of the light upon that surface, and if all mirrors used were of equal reflecting power, then there would be no need of radial adjustment of the mirror pairs, for in such case $SC = \sin\theta$ and $K_\theta = K_0$. But the so-called cosine law is only approximately true and mirrors vary in reflecting power, hence it is necessary to compensate for discrepancies in C and K_θ by slight changes in d_θ. The extent to which this correction is of importance depends, of course, upon the nature of the photometer screen. The plaster of paris surface of the Lummer-Brodhun screen obeys the cosine law with exactness up to an incidence of fifty degrees, but beyond this point a divergence of increasing magnitude occurs (Fig. 3). Hence, for the Lummer-Brodhun screen the only adjustment of mirrors necessary is that to overcome variations in their reflection coefficients, except for angles greater than fifty degrees. With mirrors cut from one sheet of glass, the correction for variation in reflecting power is often negligible. With the Bunsen screen, correction must be made for all angles of incidence. For example, the second curve in Fig. 3 is the result of measurements made upon ordinary draughting paper from which the Bunsen screen is often made. Here the departure from the cosine relation is noticeable from the very beginning and becomes as high as fifteen per cent at seventy-five degrees incidence. The third curve in the same figure shows the results obtained with ordinary glazed writing paper. The cosine relation is not even roughly approximate in this case.

Fig. 2 also shows the method of balancing the illumination produced by the series of images due to the circular system of mirrors. Mirrors M_1, M_2, M_3, M_4, are cut from one piece of glass just as are the mirrors in the ordinary Bunsen photometer. It is not essential that the other mirrors of the system should have the same coefficient, since, as already explained, the initial adjustment corrects for failure of the cosine relation and inequalities in the mirror coefficients at the same time. With the standards at S′, separated from S, the source to be tested, by an opaque screen, a balance in the illumination is obtained by moving M_3 and M_4. The method of doing this will be better understood by reference to Fig. 4, which shows in elevation and plan the essential elements of the apparatus. To the right of these figures is seen the mirror system, each pair of mirrors being capable of a certain amount of radial movement for purposes of the initial adjustment of the instrument. S is the

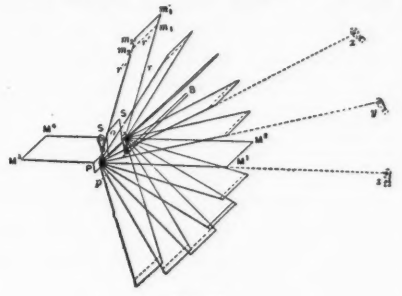


FIG. 2.

lamp to be tested, mounted upon a rotator; S′ is a standardized glow lamp. The mirrors M_3 and M_3, rigidly connected, may be moved along the bar by means of a rack and pinion conveniently under control of the observer at the photometer P. The photometer is fixed, and hence the operation of making a setting is more convenient than that which obtains with the ordinary sliding form. As the design is based upon the approximate equation (1) and not upon the integral form, some error arises from this cause. With eleven pairs of mirrors the error is negligible for all practical purposes.

Fig. 5 shows a photograph of the finished apparatus with all screens removed in order that the details of con-

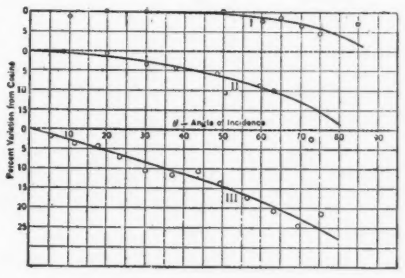


FIG. 3.

Per cent variation from cosine relation for different screens
I.—Lummer-Brodhun screen.
II.—Unglazed paper.
III.—Glazed paper.

struction may be better seen. This particular instrument is fitted with a Lummer-Brodhun photometer screen. Each mirror bracket is provided with two pins. These pins extend through the frame of the ring radially. By means of this construction, each mirror pair may have independent radial adjustment.

We will now consider in detail the different operations to which the instrument readily lends itself.

OPERATION 1—MEASUREMENT OF MEAN HORIZONTAL CANDLE-POWER.

In this operation the apparatus is used as a simple photometer. Hence, all mirrors except the four horizontal ones are covered by black screen suitably provided for the purpose. The right pair of mirrors (Fig. 4) is connected at C to the sliding rod carrying the rack. The lamp S to be tested is mounted in the rotator and driven at a speed of, say, 180 revolutions per minute, and a standardized incandescent lamp of intensity $I_{s'}$ is placed in a suitable holder at S′. The rod R may be moved by the hand for a rough adjustment, and the pinion P″ used only for the final setting. Since a displacement d of the mirror pairs means a change in the light paths of $2d$, the moving rod is graduated in divisions one-half the unit (centimetres) in which the light paths are conveniently measured. A reading R means that the distance from S′ to the screen by way of the mirrors, M_3, M_4, is R centimetres. If now the total photometric distance between the sources is 300 centimetres, we have for the intensity I of the light under test

$$I_s = \left[\frac{300 - R}{R}\right] I_{s'} \qquad (6)$$

$$= T_1\, I_{s'} \qquad (7)$$

where T_1 is the value of the expression in brackets and stands for "tabulated value corresponding to the reading R." When the apparatus is used with a standard of always the same intensity, it is a simple matter to make the instrument direct reading.

Obviously, the mean intensity in any north or south polar zone may be found by clamping the arm of the rotator at the proper angle and spinning the lamp, readings being taken as for the mean horizontal measurement. The mean horizontal candle-power of a flame source must be found by taking the horizontal distribution step-wise since it is impracticable to rotate such a source. Equation (7) is applicable in such measurements.

OPERATION 2—DISTRIBUTION OF CANDLE-POWER IN VERTICAL PLANES.

The distribution of intensity of an incandescent lamp in any vertical plane is obtained with the apparatus arranged as described under operation 1. The arm of the rotator is merely tilted about a horizontal axis so as to bring any desired aspect of the lamp toward the photometer screen. From equation (7) the different intensities are easily found.

The vertical distribution of candle-power from the flame source can not be

obtained by tilting the arm of the support. The following method is available in such cases: Mount the burner vertically at S. Disconnect the mirrors M_1, M_2 from the movable rod and push them to their place at the extreme right (Fig. 4). Now with a standard of the same order of brightness as the source to be tested, make a setting. The horizontal intensity is given by

$$I_0 = \left[\frac{200}{R}\right]^2 I_{s'} \qquad (8)$$

$$= T_2 I_{s'} \qquad (9)$$

where T_2 is the tabulated value of the expression in brackets corresponding to the reading R.

To obtain the intensity of the source in a direction of θ_0 to the vertical, the horizontal and θ mirrors should both be used. This prevents the limit of the bar being reached by mirrors M_3, M_4. The intensity is given by

$$I_\theta = \frac{T_2 I_{s'} - I_0}{\sin \theta} \qquad (10)$$

where I_0 is the intensity found in the horizontal measurement.

OPERATION 3—STANDARDIZATION OF GLOW LAMPS.

For this operation the lamp S is removed and a horizontal circular plate mounted in place of the lamp. This plate is ruled with concentric circles which facilitate the centering on the amyl-acetate lamp or other primary standard. The lamp to be standardized is mounted at S′. With all mirrors screened except the horizontal ones, and with M_1, M_2 attached to the bar, settings are made as usual. The value of S′ is given by

$$I_{s'} = \frac{1}{T_1} \qquad (11)$$

if the standard is unity.

OPERATION 4—MEASUREMENT OF MEAN SPHERICAL INTENSITY.

(*a*) Glow Lamp—The lamp to be tested is mounted in the rotator and driven at a speed of about 180 revolutions per minute. Mirrors M_1, M_2 are detached from the movable rod and pushed to the extreme right, in which position they may be considered a part of the system of eleven mirror pairs. With a standardized lamp at S′, a setting is made in the manner already described. If R is the reading, we have

$$I_{ms} = T_3 I_{s'} \qquad (12)$$

where T_3 is a tabulated value corresponding to the setting R and $I_{s'}$ the intensity of the standard as heretofore. Thus the operation has all the simplicity of any photometric measurement.

The intensity of the standard used should be approximately that of the lamp to be tested. For example, if a sixteen-candle-power lamp is to be tested, a standard of not less than sixteen candle-power is best. With such a standard, the range of possible measurement depends upon the limit of travel of the mirrors M_3, M_4. A sixteen-candle-power lamp will serve as a standard for the measurement of mean spherical intensities, ranging from two to about twenty-five candle-power, when the limit of travel is about one metre. It is best to substitute a thirty-two-candle-power standard for intensities much greater than sixteen candle-power.

(*b*) Flames—To obtain the mean spherical intensity of a flame or of any source that can not be rotated, it is necessary to repeat operation 4 at equal angular intervals on the horizontal circle.

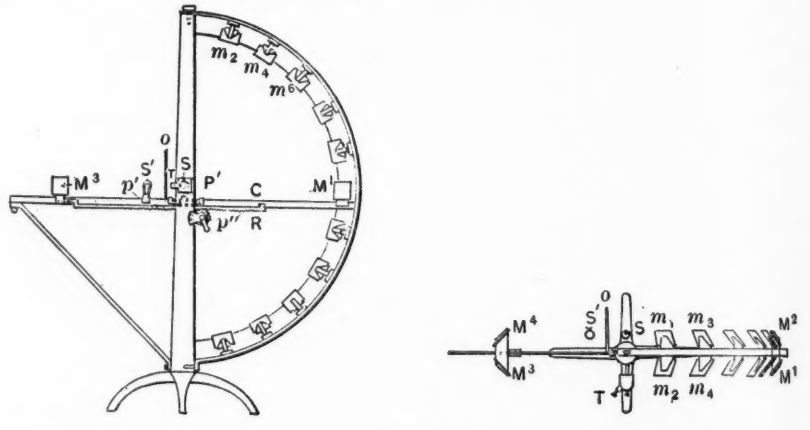


FIG. 4.

The mean of the results may then be taken.

OPERATION 5—DIRECT MEASUREMENT OF THE SPHERICAL REDUCTION FACTOR.

If the standard S′ and the opaque screen O be removed, it is clear from the figure that the left side of the photometer screen will be illumined by the horizontal rays of lamp S. In fact, if S be rotated, we will have on the right side of the photometer screen an illumination proportional to the mean spherical intensity of S, and on the left side of the screen an illumination in proportion to the mean horizontal intensity of the same source. Under these conditions the photometer setting yields the spherical reduction factor. In other words, the mean spherical intensity is measured against the mean horizontal intensity as a standard. The reduction factor is given by

$$f = T_3 \qquad (13)$$

As the removal of the standard S′ lengthens the distance from source to screen, it is necessary to add a constant to the reading. This is provided for by a second reading point, marked RF. All readings for operation 5 must be taken at this reference mark.

OPERATION 6—TO CHECK THE HORIZONTAL MIRROR CONSTANTS.

As before stated, it is essential that the four mirrors attached to the movable bar should have the same constant. To ascertain if this condition exists, remove the opaque screen and the lamp S′, as in operation 5. Connect the horizontal mirrors to the moving rod and, screening all other mirrors, take reversed photometer readings on a rotating lamp S. If the mirror coefficients are equal, the mean reading will be 150, indicating equal light paths on each side of the photometer screen. Here, again, the RF reading mark must be used.

OPERATION 7—TO CHECK THE ADJUSTMENT OF THE CIRCULAR MIRROR SYSTEM.

In case of any doubt as to the accuracy of the initial adjustment of the photometer, or in case of the substitution of a new screen, it may be necessary to readjust the mirrors of the half ring. This operation is best performed as follows: Mount at S a thirty-two nominal candle-power lamp, and at S′ an eight-candle-power lamp, the latter being in circuit with a rheostat capable of continuous variation, with mirrors M_1 and M_2 free from the moving rod, and with all other mirrors on the half-ring screened set R equal to 100 c.m. Now, while maintaining the thirty-two-candle-power lamp at constant voltage, vary the voltage impressed on the eight-candle-power lamp until the photometer shows equal illumination. Note voltage on eight-candle-power lamp. Repeat measurements with reversed photometer. The lamp should finally be maintained at the mean voltage so found. Under these conditions the

two lamps have a candle-power ratio of 4 to 1. Next tilt the lamp-holder to an angle of fifteen degrees. Uncover the corresponding mirrors ($\theta = 75$ degrees or $\theta = 105$ degrees) and cover the horizontal ones. Under these conditions we have the same aspect of the lamp toward the photometer, but with the light incident at fifteen degrees. Set the bar at

$$R_{15} = \frac{R_0}{\sqrt{\cos 15^\circ}} \qquad (14)$$

Adjust the fifteen-degree mirrors radially until an equality of illumination is obtained, then secure them by means of the set-screw. This operation may be repeated until all the mirrors have been adjusted.

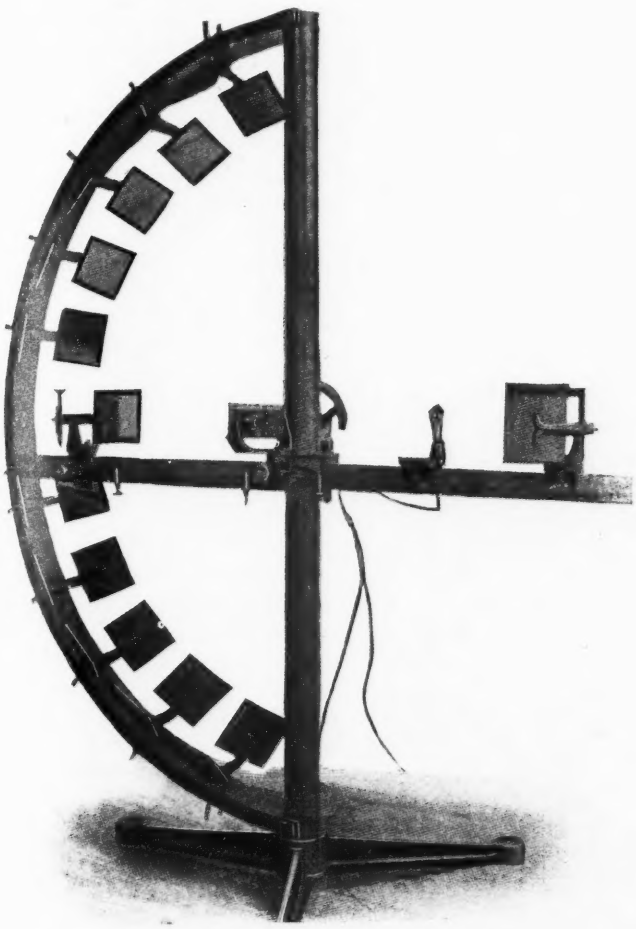


FIG. 5.—FINISHED APPARATUS, WITH ALL SCREENS REMOVED.

In conclusion, I would acknowledge my indebtedness to Messrs. D. M. Lynch and E. D. Fristoe for their painstaking labor in constructing a preliminary form of this apparatus. I am also indebted to Mr. C. R. Dooley, assistant in electrical engineering at Purdue University, for assistance.

Electric Pumping at the South Durham Collieries.

In this paper, read before the North England Institute of Mining and Mechanical Engineers at a recent meeting, Mr. F. Darling gives a brief description of the electrical pumping plant at the South Durham collieries. The John Henry pit was sunk sixty-two years ago, and is 312 feet deep. This shaft has not been used since 1877, except as a pumping station for draining the coal seams in this locality. This has been done by a Corning pumping engine. Three years ago it was decided to sink the John Henry shaft deeper, and in this way drain the lower seams of coal and enable them to be worked. There were three methods by which this could have been done—a direct-acting steam pump, a large air-compressing plant, or an electric generating plant placed at the Harry pit, about half a mile distant, and the current carried by cables to pumps placed at the main coal seam. The first scheme was objectionable, as it necessitated the erection of high-pressure boilers. The second scheme would also have involved a large outlay in air-compressing and boiler plant. The third scheme was adopted because no increase of the plant on the surface at the John Henry pit was necessary. By keeping the generating plant at the Harry pit, where a large boiler plant was already in existence, a great saving in coal is effected, and there is sufficient steam generated by the waste heat from the coke ovens to operate the electric plant. Further, the concentration of the plant would allow of more efficient supervision, as all the electric plant would be under one management. The generating plant pumps are capable of pumping the whole of the water at present met with in the seams, and so long as this is the case very little steam beyond that produced by the coke ovens will be required. In driving the pumps night and day there will be no difficulty in dealing with 1,000 gallons of water per minute during the twenty-four hours, as well as running the coal-cutting machines, and the hauling. The plant has been working since January and has not given the slightest trouble.

Sparkless Electric Plant for Use in Mine and Iron Works.

At the recent meeting of the British Institution of Mining Engineers, Mr. J. H. Whittaker discussed the advantages of various types of motor installations for mine work. The generating plant can be placed at the surface, near the mouth of the pit, and the wires may be hung directly from end to end, bare or insulated. Continuous-current motors offer some advantages, particularly the series motor, which has excellent starting properties which adapt it to operating coal-cutting apparatus. The shunt motor is not as good as a starter, but runs at a regular speed. The compound motor—a combination of the two—on the whole seems to be the most suitable for use in mining. The chief objection to continuous-current motors lies in the commutator. It is not possible to prevent sparking at all times, and in gaseous mines this may prove a source of great danger. Motors can be enclosed perfectly gas-tight, but at a greater expense in first cost, as this reduces the capacity considerably. Polyphase motors have a great advantage in that there are no moving contacts, and therefore no sparking can occur. These motors, however, have poor starting qualities, unless high efficiency is sacrificed. For large sizes of motors, starting appliances must be provided. The polyphase motors are considered ideal machines for driving the pumping plant. The advantages of the alternating-current system—the voltage of which can be changed at will by means of static transformers—are then considered. Polyphase systems are not so advantageous for lighting as continuous-current systems, but this is a secondary consideration compared with that of the motors. Arc lighting is not desirable for use in mines.

THE CONSTRUCTION OF TELEPHONE EXCHANGES—XLV.

BY A. E. DOBBS.

CENTRAL BATTERY SYSTEMS AND APPLIANCES.

The central battery idea is not new, for as far back as 1881 attempts were made to connect several telephones in series with a single battery on one line, but the troubles that arose from having several transmitters connected in this manner prevented its adoption to any noticeable extent.

It is probable that to Mr. J. J. Carty belongs the credit of first making an attempt to connect transmitters together in multiple, and if the writer's recollection of his story is correct the discovery was partly accidental and made while engaged in testing a large number of transmitters in the old Western Electric factory, then located on Thames street, New York, in 1884 or 1885. Employed in the testing department at that time he was accustomed to hang a dozen transmitters on the wall at one time and make the connections to a storage cell (Fig. 191) with annunciator, or any other wire he might happen to have, and on one occasion when testing with a helper he found to his surprise that there was no cross-talk between the transmitters. This was a nine days' wonder at the time, and some of the boys who were sent out to install exchanges tried to connect all the operators' transmitters on a single battery, but always made a failure of it, and just why it would work in the factory and fall down outside the factory was a mystery that he set his wits to solving, for he had really begun to get interested, and in company with one or two others begun an investigation, and about the first thing learned was that a battery of low internal resistance was required.

Having learned this much they tried it again in another exchange connecting from storage cells in the basement of an exchange building to the operating board with a No. 6 copper wire, but again scored a failure. It was then suggested that perhaps even No. 6 wire had too much resistance, and the wire was reenforced first with another pair of No. 6's, and still again with heavier wire, but all to no purpose, though as the feeders got heavier the cross-talk diminished somewhat until finally the heavy feeders were discarded and ordinary No. 14 wire run from each operator's transmitter back to the battery lugs, the same as had been done in the factory, and this cured the trouble. It became plain that even a slight resistance in the feed wires would cause cross-talk. Then it was discovered a little later that a feed wire could be used for a short distance from the battery if the induction coils were all grouped in one place, and also that better results

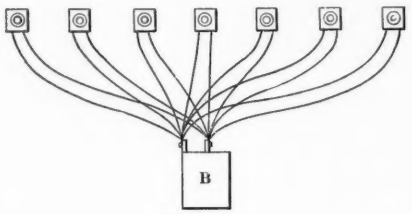


FIG. 191.

would be attained if the primary coils were wound to a somewhat higher resistance than had been customary with the single-cell batteries. Then some one (Mr. Carty modestly refrains from saying who) discovered that if a choking coil was placed in circuit with the transmitter that feeders could be run up to the switchboard and the transmitters taken from them directly, as shown in Fig. 192. It had taken about three years to

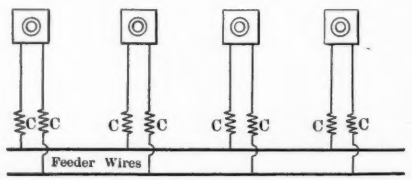


FIG. 192.

get this far, and from that time on there was considerable progress made in the improvement of details; transmitters and receivers had to be altered and considerable study given to the balancing of circuits, so that two or three years more passed before any one had the nerve to try it on the subscribers' lines of an exchange.

The plan shown in Fig. 192 then was the solution of the problem for connecting batteries in multiple without interference with each other.

The choke coils *c c* allow the battery current to flow through the line to the transmitter, but resist the return of the rapidly undulating voice waves back to the battery feeders, and though all connected to the same battery, yet they are as much separated as though thoroughly insulated from each other, so far as interference is concerned; in fact, central battery systems are remarkably free from cross-talk. Sometimes the choke coil is placed in only one leg of the transmitter circuit; sometimes it acts as both induction and choke coil; sometimes as both relay and choke coil; sometimes the transmitter is in series with the primary of an induction coil at the subscriber's end of the line, and sometimes not; sometimes the receiver is in series with the transmitter, and sometimes it is in the secondary circuit of the induction coil only; but however arranged, the choking coil, whether used as a simple choke coil, an induction, repeating coil, or relay, must find a place in the circuit near the source of battery supply and as close to the battery itself as is practicable.

When battery is furnished to the subscriber's instrument from the central office the connection to line is invariably made through the cord circuit, at least in all systems that have come under the writer's notice, the same battery being used to actuate the clearing-out signals also, of which we will speak later. This battery is also invariably bridged across the line though it is possible to connect it to one side of the line in series, but as the writer knows of no exchanges connected in that manner at the present time, he will not stop to discuss special systems, or those which have not passed beyond the laboratory stage of development.

The development of the choke coils was rather slow, as it was necessary to find the proper proportions to give the best results. It was soon found that it was not really necessary that the coils should be of high resistance, but it was quite essential that they should possess a high inductive resistance, and though the measured resistance of the coils might not exceed twenty ohms, yet their inductive resistance is great enough to prevent cross-talk between the different lines. Sometimes, however, when a high-resistance choking coil is required, which may be the case when it is used as a relay, then it

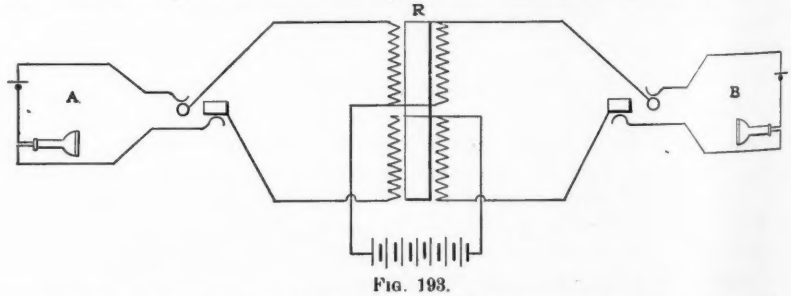


FIG. 193.

may be shunted by a condenser which is open to the steady flow of the battery, but which transmits voice currents with only a trifling loss. Indeed, in some systems the condenser plays a very important part in the transmission of speech, and when its possibilities are better understood it will yet become a very important adjunct toward increasing the efficiency of central battery systems.

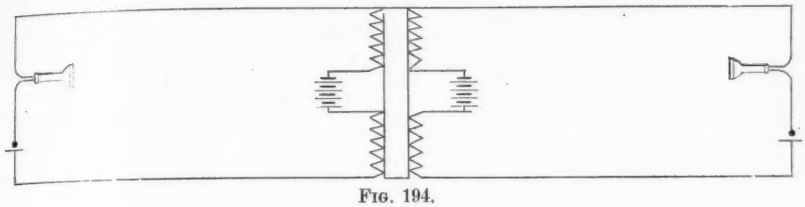


FIG. 194.

Central battery systems are improving all the time, though there is much to be done yet toward making them perfect, and it is well known that in talking efficiency the best central battery service is not as good as the best local battery transmission by at least fifteen per cent, although taken altogether they are superior to the average local battery in that the battery furnished the subscriber is more constant than that of any local battery service that depends upon a monthly inspection. Moreover, in large exchanges central battery is rather more economical than local batteries.

Referring to the figures, which are intended to show the practical application of the system, we have, first, Fig. 193 showing connections as made through the ordinary cord circuit, all signaling devices being omitted.

First, we have an induction or repeating coil on which are four windings similar to those previously described in the chapter on that subject. These coils are so arranged that the switchboard cords are connected to the outer ends and the battery connected to the centre from which the current divides equally in both directions. As a rule, both windings on these coils are equal, except in the case of toll-line cords, when one may be wound higher than the other, but in ordinary work great care is taken to have the resistance and number of turns on both coils to prevent unbalancing of the circuit. When the tube-encased coil is used, as it generally is in order to prevent cross-talk by induction, there will be two coils on the inside wound to a depth of perhaps twenty layers, and two more wound on over these of the same number of turns, so that there would be a considerable difference in the resistances of the inside and outside layers were it not counterbalanced by connecting the inside coil at one end to the outside coil at the other. When both coils are cross-connected in this manner there is apt to be but a very slight difference between them, and for all practical purposes the balance is perfect.

The figure shows the battery connected to the centre of the coil and the coil connections to the "tip" and "sleeve" of the cords, from which connection is made to the subscribers' instruments, which in this case show the transmitter and receiver in series without any induction coils or other translating devices. We now have the battery passing through both the A and B stations. Let us now

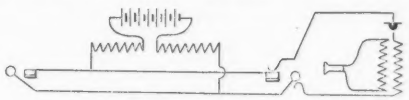


FIG. 195.

suppose that station A is talking, which, of course, introduces a considerable variation in the resistance of the line which again causes like changes in the amount of current passing through the transmitter. Now, these changes can not pass through the coil back to the battery, but they do affect the companion coil on the repeater R, which in turn is reflected upon the other circuit by way of the core of the magnet and by the influence of the two adjacent coils upon each other. It might be thought that as the coil, on the upper line for example, is doubled back upon itself, and would therefore to a great extent be non-inductive, that the current would pass through the coil and out again, although inductive, as far as the battery is concerned, as it can only enter the battery in one direction. Yet in Fig. 194 we have another form equally successful, in which there are two batteries connected to the centre of the coils on one core, though the two sides of the circuit are entirely separate from each other. In this case the effect is plainly inductive.

As shown in Fig. 192 each choke coil is separate from the other, but it is not impossible to place the two choke coils on one core as indicated in Fig. 195, an arrangement by which the choke coils can also act as two separate relays to give clearing-out signals, a practice followed by at least two manufacturers. There is also another difference in Fig. 195 that will be observed in the station telephone, the introduction of an induction coil at the subscriber's instrument, and, further, that the receiver is not connected directly to the line, but only in the secondary circuit of the induction coil.

As a matter of fact, the majority of central battery instruments are connected in a similar manner, it having been found by experience that this generally gives the best results with most systems, though there are notable exceptions.

In regard to choke coils it might be added that one manufacturer has attained very fair results by using one choke coil in the cord circuit instead of two as in Fig. 192.

Fig. 196 shows how several subscribers are taken from one battery and is self-explanatory, the feed wires being connected to the cord coils.

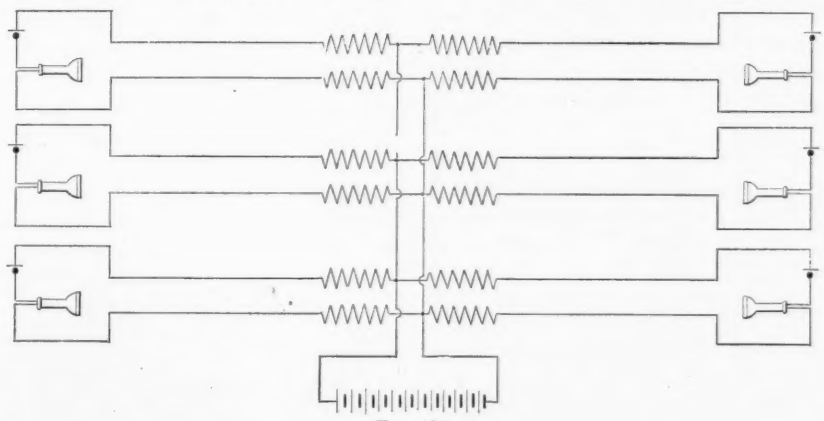


FIG. 196.

The first requisite in these systems is that the battery shall have a very low internal resistance, and so far the storage battery is the only one giving satisfactory results. In order that the resistance shall be as low as possible very heavy wires are carried from the battery room to the switchboard, wire smaller than No. 0

not being considered advisable. Sometimes, however, this feeder instead of being carried as far as the switchboard is terminated in a bus-bar close by the battery switchboard, and all the choke coils mounted there and smaller wires cabled to each cord separately.

It has been already pointed out that the internal resistance of the battery should be very low, and though the voltage used by different manufacturers varies from twenty to forty, which will, of course, make a difference in the battery capacity, for the higher the voltage the less the current used, yet it is never advisable to use cells having a less capacity than 120 ampere-hours, which indicates an internal resistance of about 0.015 of an ohm.

It is also necessary that the batteries shall always be in duplicate, as in this way one set can be charged and the other discharged at the same time, and there is always one set in reserve in case anything happens to the other. For the same reason there should always be two charging dynamos, or in case the current is taken from the street mains there should be one dynamo connected to a gas or steam engine and held in reserve for emergencies should anything happen to the outside current supply.

Signal for Electric Crossings in Leipsic.

Consul B. H. Warner describes an apparatus designed to prevent accidents at street railway crossings in Leipsic. An automatic signal lantern has been introduced by the street railway companies, which consists of two boxes arranged one above the other, each having two sides fitted with red, and the other two with green, glass, the red being above the green. Cars on one line cause the incandescent lamps in the upper box to burn—cars on the other line, the lower one. This causes on the approach of a car, owing to the arrangement of the glass in the box, a green light to appear on one line, which indicates free passage, and a red light on the second line signals "stop." This does away with the necessity of having the conductor run ahead to inspect the crossing and signal to the motorman when the line is clear. Signals are also visible in the daytime, as reflectors shut out the light of the sun, and the apparatus is well lighted from the inside.

For plating silver when batteries are used for circuit, the cyanide of silver is of general use.

CORRESPONDENCE.

The Central Station and Heating Systems.

To the Editor of the Electrical Review:

I am quite interested in the perusal of your article in the Electrical Review of October 11, in which you state that certain gas and electric light companies in Boston propose to unite, the object being to encourage the use of gas for heating and cooking, leaving the lighting field altogether to electricity. The object is, of course, to do away with isolated electrical plants, which would be the case, to a very great extent, if the electric light company can supply heat as well as light and power. This loss of business by the electric light companies in the large cities, because the customer will light himself if he has to supply his own heat, becomes a serious matter, causing the multiplication of isolated plants and restricting the electrical field of operations very materially for the company.

You suggest an increased use of gas for heating, which is well, although the cost is considerably greater than heating with coal, which is partially compensated for by its convenience and freedom from ashes and dust. You also call attention to the heat lost in the exhaust steam from power-houses and factories, and that much of this could be saved if used for heating, which you say is being done already in a great many small towns.

I think you underestimate the amount of heating that is being done in this way in the large cities. Electric light and railway companies in such towns as Springfield and Peoria, Ill.; St. Joseph, Mo.; Lincoln, Neb.; Lima, Ohio; Baltimore, Md.; Atlanta, Ga., and many smaller towns are using exhaust steam for heating, delivered through underground pipes with marked success and profit. All these companies have each several thousand feet of pipe laid—some as large as eighteen-inch—by means of which residences, stores, offices and public buildings are heated to perfection. Condensing is, in economy, not to be compared with this use of steam for heating, and is a serious waste of energy in comparison.

Heating from this source is in the line of economy for the customer and his heat can be supplied much cheaper than gas for the same purpose, while the same advantages accrue to the customer; *viz.*, exemption from smoke and dust, also his heat is always constant, and, having no fires to make, his heat is regulated by simply the opening and closing of his radiator valves.

Steam for heating is as staple an article as the electric current for lighting and there is no valid reason why the electric power station should not heat all kinds of buildings as well as light them, particularly when by so doing its electrical field is largely extended. Certain it is that central station heating will soon be in general use, if not from the electric power stations, then by companies supplying steam direct, as a good many are doing already. I. H. Babcock.

Lockport, N. Y., October 23.

Condenser Capacities.

To the Editor of the Electrical Review:

Allow me to call your attention to an error in Mr. A. E. Dobbs's article in the Review, October 11, 1902.

He says that by placing plugs, as shown in Fig. 188, the five sections are connected in multiple and the capacity is one microfarad. If he will look carefully over his diagram, Fig. 189, he will see that every section is short-circuited and therefore the capacity is *nil*.

The highest capacity he can possibly obtain from such a condenser is five microfarads, and the greatest number is very limited.

The multiple series condenser from which the maximum number of different capacities can be obtained from a given number of sections is manufactured under patent rights granted to Mr. William Marshall, the well-known condenser expert. Arthur Graham.

October 21.

Charging of Telephone Magnets.

To the Editor of the Electrical Review:

In the third instalment of his article on "The Designing of Telephone Apparatus," Mr. W. A. Taylor, citing the methods employed in charging the permanent magnets for telephone receivers, states that in practice the keeper of the charging magnet is replaced before the charged magnets are removed. This seems to be an unnecessary precaution—in fact if the charged magnets were pulled off the charger the tendency would be to aid the permanent set, and might prove more desirable than rapping.

Thomas A. Nathans.

Fordham, N. Y., October 11.

A Correction.

In our "Notes from Great Britain" under date of September 13, 1902, it was stated that the General Electric Company was legally blamable for the catastrophe during a fire which occurred in that company's London building a short time ago. This fire was in the building of the General Electric Company, Ltd., and it now appears that there is no connection between the General Electric Company, Ltd., and the General Electric Company.

THE DESIGNING OF TELEPHONE APPARATUS—VII.

BY W. A. TAYLOR.

THE GENERATOR.

On account of the demand for a generator which will ring a large number of telephones on a line it has become necessary to constantly increase the size and output of the machine. It is not uncommon to find a generator which will ring forty telephones on lines of twelve or fifteen miles in length.

The magneto generator is nothing more than a dynamo, and conditions which apply to one will apply to the other. What is to be obtained is as strong a magnetic field as possible, a large number of turns on the armature and a low resistance to the winding. The usual shape of the cross-section of the armature is shown in Fig. 12. The curved portions, *a b*, at the opposite sides are ninety degrees arc. The web *c* is made of as large cross-section as possible without confining the wire to too small a space. The web should be large in order that the resistance to the passage of the lines of magnetism may be small. The armature revolved between poles which come close to the cheeks of the armature core. One-fiftieth of an inch is the usual air-gap. These pole-faces are of ninety degrees arc. When the armature core is in the vertical position, as in Fig. 12, the armature corners should be just opposite the corners of the pole-pieces P. If the core-cheeks are narrower than the opening between the corners of the pole-pieces, as in Fig. 13, there is too long an interval between the reversing of the current. The same difficulty is experienced where the core-cheeks are two wide, but in this case a considerable amount of the magnetism passes across through the cheeks, as shown in Fig. 14. It is important that just as soon as the corners *a* and *b* (Fig. 13) of the armature leave the corners of the poles, that corners *c* and *d* approach the pole-pieces. It is at the vertical position of the armature where the lines of force change their direction through the coil of the armature.

The armature core is generally made of soft metal, either Norway iron or of very mild open-hearth steel. The usual practice is to make up the armature core of a number of punchings of the latter material. These punchings or laminations are slipped over the shaft and fastened to it securely.

It is a natural fact that a soft cast-iron core gives as good results as the built-up core. It is hard to get a uniform grade of soft cast iron, however, as when the castings are delivered there are a large number which are chilled. The cores could be made of cast steel, of course, but they would be more expensive to work up. So it is more a matter of shop economy to use the built-up core than an electrical necessity.

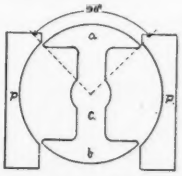


FIG. 12.

The magnets are made of the same grade of steel as that which is used in the receiver, and it is treated in the same manner. There are two sizes generally used—three-eighths inch by three-quarters inch, three-eighths inch by one inch and one-half inch by three-quarters inch. The latter size is that which is most generally used. In bending the magnets some makers insist upon a cold bend, claiming better results. It is doubtful whether this contention can be proved. It certainly takes more power to bend the steel cold, and as it must be heated subsequently it is a useless waste of energy. If arrangements are convenient it is possible to bend up the magnets hot and chill them in one heat, and thus save a large amount of power and also expense for a heavy bending-press. So far as the writer's experience goes this latter method has given as good results as is possible to obtain.

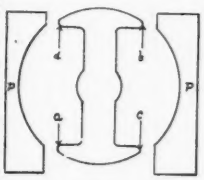


FIG. 13.

If there is one leg of the magnets slightly longer than the other it is best to have them magnetized so that the longer legs are all of one polarity. These long ends should be placed on the front of the machine, and then the magneto generator will present a better appearance. It is always best to have the poles at the front of the generator of one polarity for all machines, and to have all windings connected the same, for if there is ever an occasion to make it into a direct or pulsating generator the polarity of the current in each will be the same. Uniform polarity of pulsating generators is especially necessary where biased bells are to be rung selectively. Before magnetizing all grinding, buffing and nickel-plating should be done. A keeper should be kept on all magnets until they are ready to be put on the generator. If they are placed upright on an iron plate or in pairs with the north pole of one against the south pole of the other, and kept that way till used, there will be no trouble.

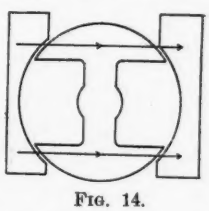


FIG. 14.

It is the general practice to make the magnets about five inches high; anything shorter is bad practice. Even with the above height a strong current is likely to demagnetize the generator. The greater the output in ampere-turns the greater the danger of demagnetization, and especially so if the machine is a power-driven generator, which is apt to have short-circuits and other heavy loads thrown upon it.

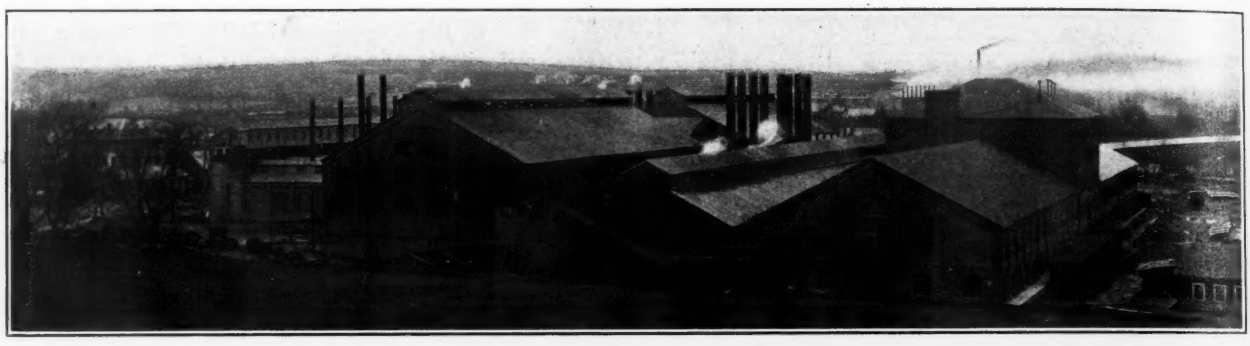
The pole-pieces are generally made of cast iron milled up true on the face. The softest grade of cast-iron should be used. Some makers use a pole-piece formed up from sheet metal, and it is claimed that they get very good service from these. The pole-pieces should be shaped so that the side next to the magnets is flat and with a large bearing surface. The lower edges should be milled flat and smooth, for it is upon these edges that the generator stands. The ends must be machined off perfectly square and flat, for the bearings of the machine are here supported. The holes in these ends, within which the screws that hold the end-plates are driven, must be accurately placed. A good jig for this purpose is an absolute necessity. The end-plates of cast brass holding the armature and countershaft should fit accurately. The armature bearings should have a good length so as to wear slowly. Should these bearings wear down even a small amount the armature would rub on the pole-pieces and run hard. The gears should be of brass with milled teeth and face at least a quarter of an inch wide. The ratio between the gear and pinion should be some incommensurable ratio so that the same teeth will not come together at each revolution. The pinion should be connected to the armature shaft by means of springs, so that in driving all the unevenness is taken up by these springs. These springs must be made strong enough so that they will not break, and at the same time they must not be stiff.

There are two kinds of generators in use—the series and the bridging. These generators differ only in the quantity of current and output. At present the series generator is used only where there is but one telephone on a line connected to the exchange. There is no necessity of great strength here, and therefore it is made smaller, and with smaller current output.

Electric Apparatus in a Modern Cement Mill.

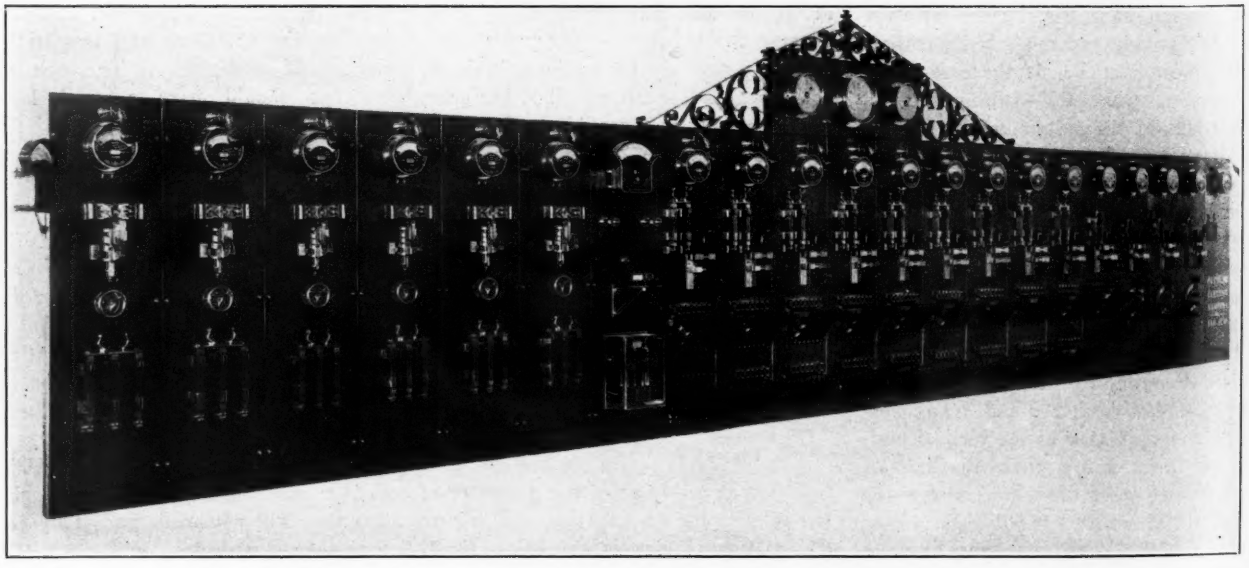
Modern Equipment Applied to an Old Industry.

FEW industries have had such marvelous growth as the manufacture of Portland cement in the United States. This material, which has become so necessary in all of our building and engineering operations, has been manufactured in this country only comparatively recently. The manufacture and use of hydraulic cement date back to the year 500 B. C., the Romans having been the first great builders in concrete. The architects of those days paid particular attention to the use of cement for the construction of walls and pavements, and although the article produced in those times was good, it can not be compared with the Portland cement as manufactured scientifically today. The Roman cement varied considerably in quality and required a considerable time for setting. It is stated that when used for bridge foundations it was necessary to keep the cofferdam empty for not less than two months in order that the masonry might harden. Nevertheless, that the Roman builder had great faith in his cement is proved by the fact that the dome of the Pantheon—which has an internal diameter of about 140 feet—is built of concrete.



WHITEHALL PORTLAND CEMENT COMPANY'S WORKS, CEMENTON, PA.

Cements of more or less satisfactory kinds were used all through the Middle Ages, but it was not until the latter half of the eighteenth century that the material received adequate attention and was manufactured scientifically. The history of Portland cement may be considered as beginning with the work of John Smeaton and the Eddystone Lighthouse in 1756. Smeaton tested many limestones, and found that the acquisition of hardness under water did not depend upon the hardness of the stone from which the lime was made, as had been believed by all previous authorities. The next step in the progress of cement making was taken by James Parker, of Surrey County, England. His work was followed by that of Joseph Aspein, who, in 1824, filed a patent on a process for making a material which he called Portland cement. From this time on, the quality of the cement improved as the problem was studied scientifically, and it only remained for John Grant, by a thorough and systematic series of tests in connection with building the London drainage works in 1859, to add a final stamp of excellence to Portland cement, and before long the term "Roman cement" became little more than a memory.



SWITCHBOARD CONTROLLING THE ELECTRICAL MACHINERY AT THE CEMENT WORKS, CEMENTON, PA.

The first Portland cement used in this country was imported in 1865. Its introduction was slow, but it soon began to find favor among American engineers and architects.

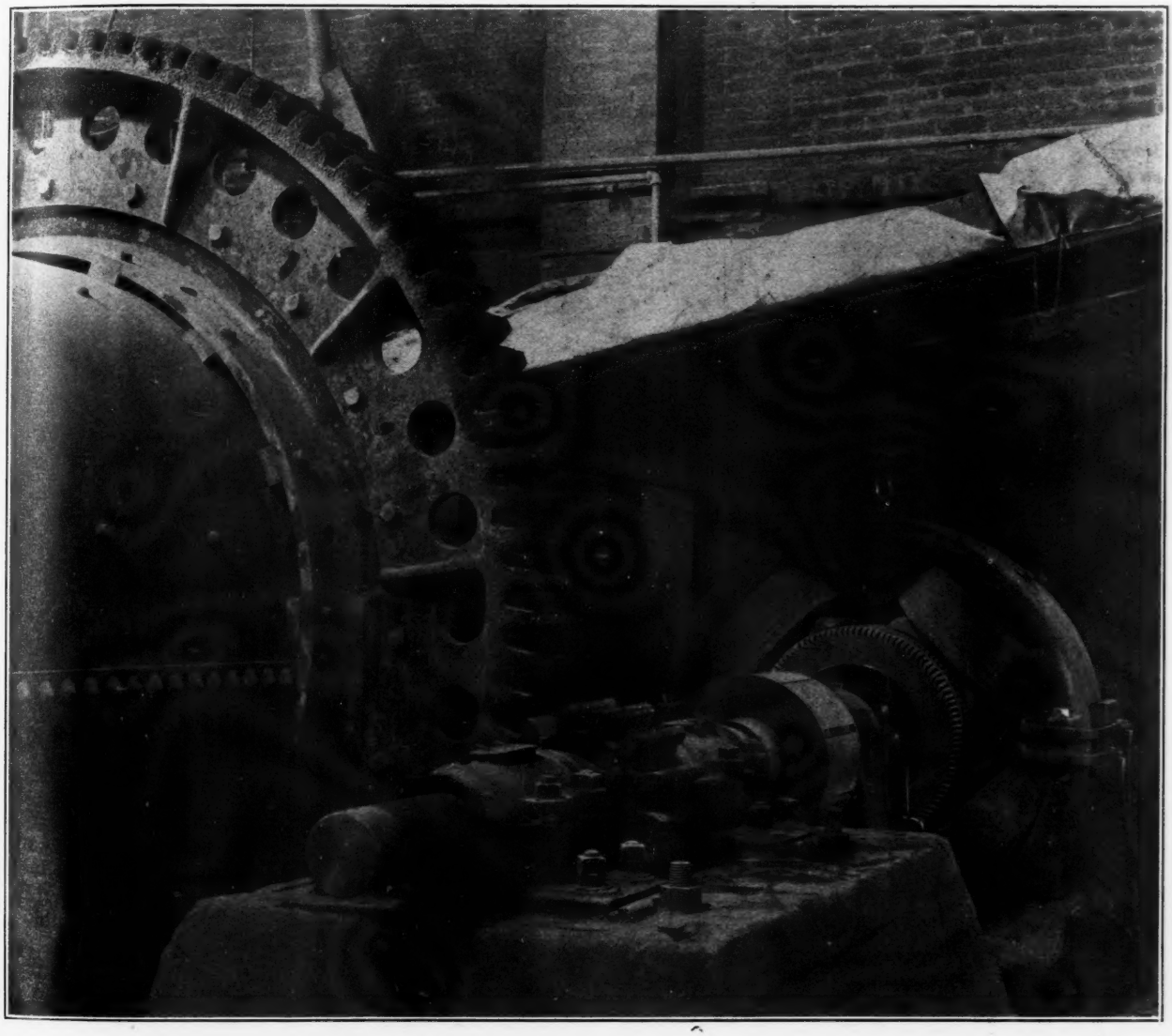
Realizing that there was a market for this material, American manufacturers set about to furnish the material themselves, and, in 1872, after many difficulties and much experiment, this was first done in the United States at Copley, Pa. In 1880, 42,000 barrels were manufactured in the United States and 187,000 barrels were imported. In 1901 nearly 13,000,000 barrels were manufactured in the United States and over 900,000 were imported. These figures show the development of the American industry and illustrate how great a success can be achieved by the application of scientific principles in industrial operations.

It is probable that very few of our readers have any conception of the vast quantity of machinery required and the enormous amount of power used in transforming cement rock as it is taken from the quarry into the marketable product known as Portland cement.

Portland cement, briefly speaking, is formed by burning a mixture of lime, silica and alumina which has been intimately mixed and finely ground, and then grinding the clinkers again into a fine powder. The product must have the quality of hardening either in water or in air after being mixed with water, and that either alone or when combined with sand. It should have a greatly increasing strength with age and should retain a practically constant volume. It is immaterial from what source the raw material is drawn so far as the cement is concerned, provided the proper proportions of the right substances are secured. These, according to authorities, should consist of from twenty to twenty-five per cent of silica, from four to ten per cent of alumina, and from fifty-eight to sixty-seven per cent of lime. Other materials, such as magnesia, sulphuric acid and iron may be present in small quantities without detriment, but these should not be considered essentials and are generally present in the nature of impurities.

The raw material as obtained in the quarries is first passed through stone crushers. The various ingredients may or may not be mixed at this time. The main point to be remembered here is that an intimate mixing is necessary, and it is immaterial at what stage of the process this is done. After passing through the crushers, the ore is passed to a drier, usually of the rotary type, and is thoroughly dried before the finer grinding is undertaken. From the driers the material passes to a ball mill. This consists essentially of a revolving drum, in which are a number of steel balls. This mill reduces the material until it passes through the sieve surrounding it, and this stage of the process covers half the reduction from the crushed to the finer ground material.

From the ball mill the raw material passes to the tube mill for its final grind-



ELECTRIC MOTOR DRIVING CRUSHER AT THE CEMENT WORKS, CEMENTON, PA.

ing. This mill is an iron cylinder about four feet in diameter and from twenty to twenty-two feet long, lined inside with hard flint stone, and kept about half full of flint pebbles. These pulverize the material as the cylinder revolves. A combination of one ball mill and one tube mill of the size indicated is ordinarily estimated to grind material for about 400 barrels of cement per day.

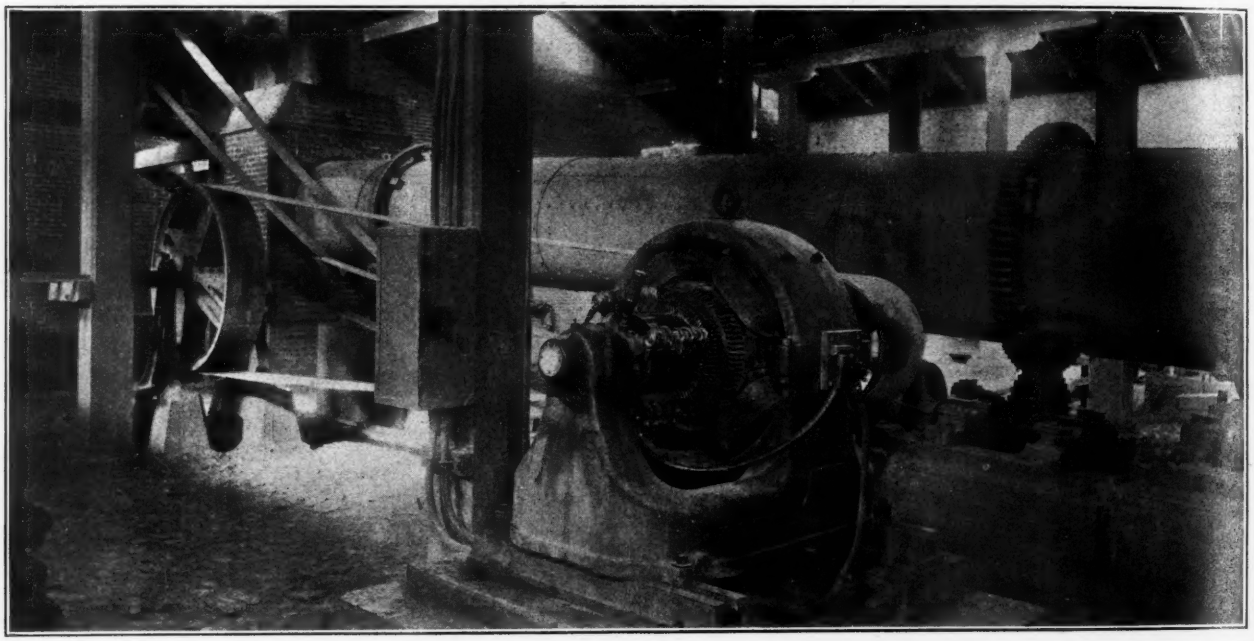
From the tube mill the ground material usually goes into storage bins before being carried to the kiln. These bins are intended to hold enough material for one day's run, so that in case of an accident to the drying machinery the mill will not have to shut down. From the storage bins the material is passed by means of conveyors to the hoppers which feed the kiln. These are usually of the rotary type, and consist of a steel cylinder five to seven feet in diameter and about sixty feet long, which is mounted on roller bearings, so that it can be slowly rotated while in operation. This kiln has an incline of about fifteen degrees. It is lined on the inside with fire brick, and the upper end is enclosed in a brick housing, which also forms the base for a smokestack and contains the conveying spout for the raw material. The latter, entering here through a water-jacketed spout, works its way slowly down to the lower end by gravity as the kiln revolves. The lower end of the kiln has a hood or door made of a circular iron casing filled with fire brick. Through this passes the fuel in the form of powdered coal driven in by an air-blast. This gives a temperature from 2,000 to 2,800 degrees Fahrenheit. The capacity of a kiln of this size varies from 150 to 220 barrels in twenty-four hours.

The clinker leaves the kiln red hot, and is discharged into sealed concrete cooling vaults located directly under the floor. Here it is cooled by blasts of air driven in from below, and the hot air drawn out at the top is supplied to the air-blast for injecting the coal dust. The cooled clinker is discharged into cars, which transfer it back to the ball mills, and the process of regrinding is practically the same as that of preparing the raw material. The point that must always be kept in view is the necessity for exceedingly fine grinding.

In a mill of this kind, where everything is covered with dust and dirt, the use of electrical driving would not seem advisable, as a more severe test of this system could hardly be imagined. That electrical driving is able to meet these conditions satisfactorily has been amply proved in a number of mills, and particularly in that of the mills of the Whitehall Portland Cement Company, at Cementon, Pa.

The electrical power plant of this company was installed two years ago, and at this time has a capacity of about 1,000 kilowatts. The boiler room contains 1,500 horse-power in Stirling boilers. In the engine room there are two 700-horse-power cross-compound engines, made by the Vulcan Iron Works Company, of Wilkesbarre. These run at seventy-five revolutions per minute, and each drives through belts two 225-kilowatt Keystone generators, manufactured by the Keystone Electric Company, of Erie, Pa. These run at 550 revolutions per minute and furnish current at 250 volts. In addition to these four generators, there are two thirty-kilowatt Sprague generators, delivering current at 130 volts for lighting.

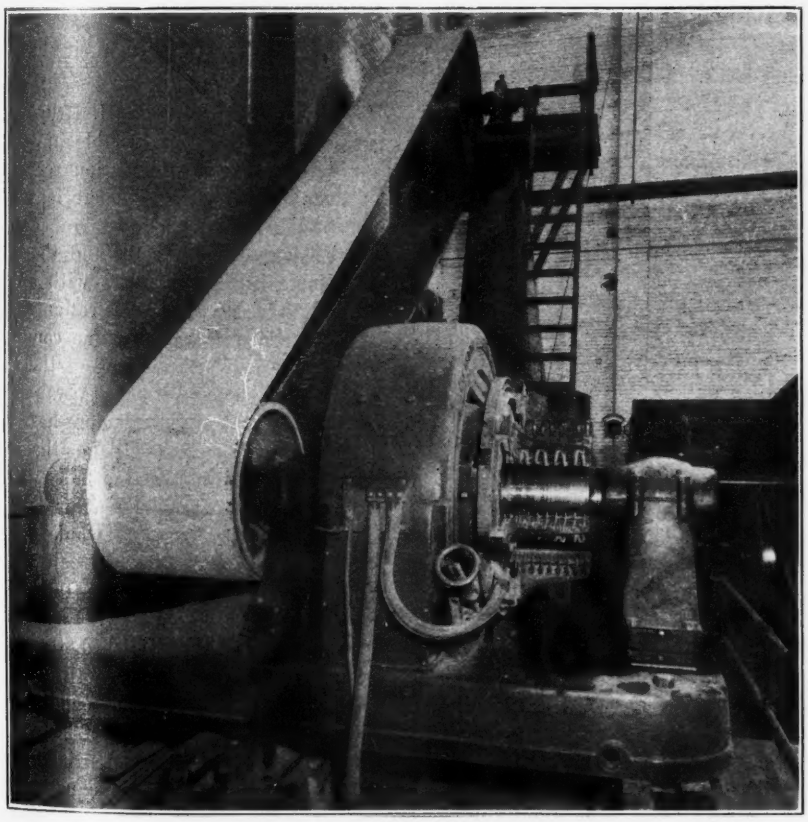
The four power generators operate at nearly their maximum load for twenty-four hours per day. From these the leads are carried to the switchboard, which is built up of twenty-one panels of black slate. The completed board is forty-two feet long and eight feet high, and stands three feet from the wall. It was built by the Keystone Electric Company. It has a number of unique features, the most striking one being the mounting of the motor-starting boxes on the board. The operating engineer then has control of all the motors from the switchboard, and stops and starts them when signaled from the point where the motor is located. This arrangement prevents serious overloading of the station such as might easily occur if several of these large motors were to be started at the same time. There are ten motor panels containing starting boxes for nineteen motors. Each circuit has an independent ammeter and a circuit-breaker. There are six generator panels, each containing a three-pole main switch, field rheostat, circuit-breaker and ammeter. A station



ELECTRIC MOTOR DRIVING TUBE MILL AT THE CEMENT WORKS, CEMENTON, PA.

panel contains the voltmeter and integrating wattmeter for recording the total load on the station. Very careful readings of the machine ammeters are taken during the day, and these must check up with the readings of the recording wattmeter. Steam gauges and a clock are mounted over the centre of the board.

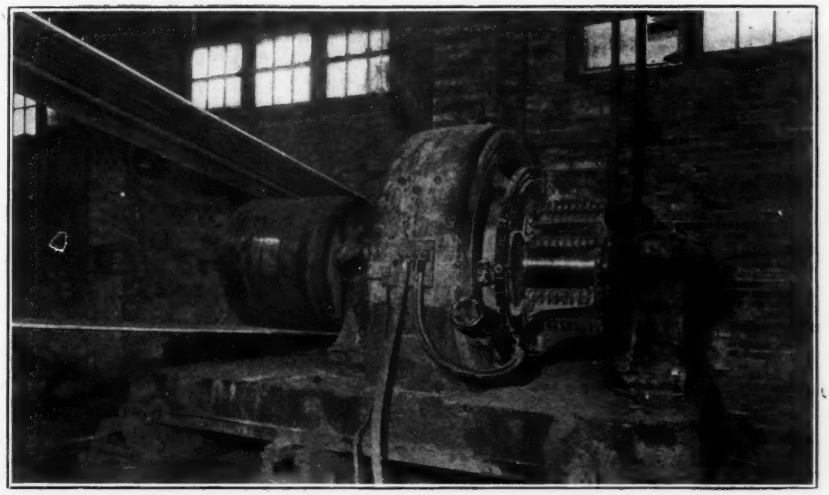
All the machines used in this cement factory are operated by electric motors, and in spite of the unfavorable conditions obtaining in cement factories, these have not given the slightest trouble since their installation, the dust seeming not to interfere in the least with their successful operation. The ore is brought into the mill from the quarry on an elevated tramway. These cars are drawn by a rope by means of an electric motor. The operator for this tramway is located at the crusher house, and by means of the controller and a system of levers brings in the cars from the quarry and dumps the ore into the crusher. This arrangement saves the employment of from three to four men and more than doubles the amount of ore that can be handled in a day.



Electric Motor Driving Ball Mill at the Cement Works, Cementon, Pa.

The crushing is operated by a 250-horse-power electric motor, and although the work is very severe, the motors have never given the slightest trouble, running twenty-four hours a day. From the crusher, the cement passes to the ball mill by means of a conveyor, also motor-driven. The ball mills are operated by seventy-five-horse-power motors, direct-connected and running at a speed of 215 revolutions per minute. From the ball mills the cement passes to the tube mills by means of conveyors, and from the tube mills it goes to the roasters. Both the conveyors and roasters are driven by electric motors.

The powdered bituminous coal used in the roasters is crushed in a mill driven by a seventy-five-horse-power motor and is blown in by means of blowers driven by 100-horse-power electric motors. From the roasters the clinker is carried by conveyors to the cooler, and from thence back through the ball mills, where it is reground and bagged, and is then ready for shipment.



Electric Motor Driving Roaster and Conveyor at the Cement Works, Cementon, Pa.

The whole output of this plant is fifteen carloads, or 15,000 barrels, of the best grade of Portland cement per day. All of the machinery, as shown, has been operated satisfactorily and economically by direct-current motors for two years. The plant is about to be enlarged, and all additional machinery will also be operated by the same system.

A careful record has been kept of the power used to operate each class of machinery, and direct driving by motors has been adopted wherever the advantages of this system were sufficient to offset the first cost.

This plant furnishes a good example of what can be done with electric motors under adverse conditions when the plant is laid out and operated with intelligence and skill. Mr. W. E. Erdell, superintendent of the Whitehall Portland Cement Company, is to be accredited with the successful operation of this installation.

We are indebted to Mr. H. B. Coho, manager of the Keystone Electric Company, at New York city, for the information and photographs describing this plant.

Large Electrical Power Transmission in India.

A large electrical generating station has just been opened in Southern India, just below the Cauvery Falls, which are on the borders of the Mysore state. They are situated in wild country, thirty miles from a railway. All the heavy machinery had to be conveyed over this distance by bullocks and elephants. The electrical power is conveyed across the jungles for a distance of over ninety miles to the Kolar goldfield, where all the mines will henceforth be entirely worked by it.

Reviews of Current Engineering and Scientific Literature.

Giving Concisely the Substance of Important Papers in the Scientific, Electrical and Engineering Press of the World.

Tram-Car Driving.

Mr. H. B. Phillimore has considered the best disposition of the controlling apparatus upon the platforms of electric cars. The principal consideration should be to place all controlling handles and pedals in such position that they can be manipulated by the motorman without it being necessary for him to move from his position, and he advises the use of a sand pedal, to be operated by the heel of the right foot. He then urges the managements of electric roads to train the motormen thoroughly in making emergency stops, as even an experienced man may lose his head if the car gets slightly above its usual maximum speed. By thorough training, the motorman instinctively controls the car to secure the best results, and is enabled to make much quicker stops under emergencies.—*Electrical Review* (London), October 10.

The Swan Falls Trade Dollar Transmission.

Steam coal costs $15 per ton delivered at the Trade Dollar Mines, in Idaho, and the adjacent country is devoid of timber for fuel purposes. As the fuel bill amounted to $50,000 annually, it was decided to install an electric transmission plant on Snake River, at a point where there was a natural fall of about ten feet. A crib dam was constructed after considerable difficulty, due to the high velocity of the stream at this point. A building, 44 feet by 140 feet, runs lengthwise across the stream at the dam. Six wheel pits have been provided, though but four are at this time in use. These four contain each a seventy-two-inch vertical McCormick turbine, operating under a head of seventeen and one-half feet, at a speed of seventy-eight revolutions per minute. These wheels drive through bevel gears a jack-shaft, from which the generators are driven by belts. The governor used is a type "B" Lombard, the pump of which is driven by a seven and one-half horse-power induction motor, and the governor end is driven by a three and one-half horse-power motor. There are three generators, each of 300 kilowatts capacity, 500 volts, sixty-cycle, two-phase, running at a speed of 514 revolutions per minute. Two 15-kilowatt, 125-volt, multipolar machines are used for exciting. The switchboard is of white marble, and contains one exciter panel, three machine panels, two feeder panels and one panel for local distribution. There are four transformers in use, and one in reserve. Each is of 160 kilowatts capacity, stepping the voltage from 500 to 22,000 volts. These are connected two-phase on the low-tension side, and three-phase on the high-tension side. The high-tension switches are of the broomstick type. Time element circuit-breakers are provided, and static interrupters. The high-tension feeders leave the building through a hard rubber tube four feet long, enclosed in a seasoned piece of timber six inches square and three and one-half feet long, which, in turn, passes through a piece of marble thirty inches square and one and one-half inches thick. The pole line is thirty-two miles in length. Round cedar poles, with an average length of thirty-five feet, are used throughout. The line is of No. 4 hard drawn copper, the wires being placed four feet four inches apart in an equilateral triangle. Power is distributed to various places in the company's property. Motors are used in sizes from two to one hundred horse-power, and have entirely supplanted the steam equipment.—*Journal of Electricity, Power and Gas* (San Francisco), October.

Physiological Effects of Roentgen Rays.

The skin disease called radio-dermatitis, caused by excessive exposure of the skin to Rœntgen or Becquerel rays, has been carefully studied by Dr. Oudin. The malady is painful and difficult to cure. The first symptom of acute and deep-seated radio-dermatitis is a reddening of the skin, which appears twenty-four to thirty-six hours after exposure. For from ten to twenty-five days the skin becomes covered with small vesicles and itches violently, and at the end of this period it begins to peel off. In more serious cases, ulceration may set in and last for months. No treatment has been found capable of stopping the development of the disease, though applications of cocaine or orthoform dressings give some relief. Red-light treatment appears to accelerate the course of healing. A chronic radio-dermatitis frequently attacks the operators, affecting especially the fingers, which become red and swollen. This can be prevented by the use of gloves containing a wadding of very fine brass wire. To protect his patients, the author uses fairly strong rays and short exposures, gradually increasing in duration. For difficult radiographs he gives an exposure of thirty seconds at the first sitting, one minute two days afterward, and so on until the exposure is increased to three minutes. The tube is held five centimetres from the skin. The exposure can be gradually raised to five minutes, but this must not be surpassed.—*Archives D'Electricité Medicale* (Paris), September.

Insulation Measurements of Continuous-Current Installations Made During Operation.

This article, by Dr. T. H. Bruger, describes a method and suitable apparatus for determining the insulation resistance of a conductor during the operation of the plant. The method consists in connecting between one conductor and the earth a suitable battery in series with an adjustable resistance. A galvanometer is also connected from this same conductor to the earth. The resistance of the rheostat is then buried until the galvanometer indicates that the conductor has been brought to the same potential as the earth. Under this condition there will be no flow of current from this conductor through its insulation, so that the whole leakage from the other side of the circuit returns to the generator through the adjustable rheostat and the batteries. When this condition has been established, the fall of potential which takes place through the insulation of the second conductor is equal to the potential furnished to the system, while a fall of potential through the adjustable rheostat is equal to that given by the battery. The insulation resistance can be then computed, as it bears the same relation to the resistance introduced by the auxiliary rheostat as does the potential of the system to that of the battery. By changing the connections of the battery and the galvanometer from the

first conductor to the second, the insulation resistance of the first conductor can be determined in the same way. The author then describes a practical form of testing set which has been developed for work of this kind, and further discusses the application of this method to determine the insulation resistance of systems having more than two conductors.—*Electrotechnische Zeitschrift* (Berlin), October 9.

Nernst Lamps in Vacuo.

This is an interesting note by Mr. E. Bose on the behavior of a Nernst lamp filament when placed in a vacuum tube. When a continuous current is passed through the glower and the air exhausted, the electric resistance decreases with the decreasing air pressure. By adding external resistance, so that the current strength is maintained constant, the intensity of the light diminishes noticeably, finally becoming a dull red. As soon as the air is readmitted the glower becomes bright again. When the glower is kept in a vacuum for some time its white color changes into gray, and finally into black. On readmitting the air, with the current still flowing, the pure white color is restored. If the current is cut off before the lamp is taken from the vacuum the glower remains black, but the white can be reproduced by heating in the air. These experiments are thought to prove conclusively that the glower of oxides of the Nernst lamp conducts electrolytically, and that the reduction of the black metal takes place in the vacuum, the metal being reoxidized when the glower is heated in the presence of air. This assumption of electrolysis is supported by the observation that no high vacuum can be obtained when the current is switched on, as oxygen is liberated. None of these phenomena is observed when alternating currents are supplied. The electric resistance and the light intensity remain unchanged, and a high vacuum can be produced. When the glower is luminous in a vacuum—due to a continuous current—a blue light is seen to surround it. The higher the current strength is raised, the more intense becomes this blue light. This may be explained on Rayleigh's theory of the blue of the sky. The pencil is surrounded by an atmosphere of metallic vapor, which is slowly burned in the presence of some electrolytic oxygen. Metallic particles are formed, of very small dimensions, which favor, in their reflection, light of short wave-length.—*Goettinger Nachrichten* (Berlin), November.

Oil Burning with Induced Draught.

A test of the possibilities of a high-duty, oil-burning furnace was made recently at the works of Messrs. John Brown & Company, Ltd., Sheffield, England, with the Ellis & Eaves system of induced draught. The boiler used was of the ordinary multitubular marine type. The system consists in inducing a draught in the furnace by means of a fan which is placed at the bottom of the uptake or chimney. The air supplied to the furnace is passed through a tubular superheating arrangement by which its temperature is raised to about 300 degrees Fahrenheit before delivering to the fires. This improves the combustion and reduces the temperature of the waste gases. The total heating surface of the boiler was 1,200 square feet. The usual coal grate was removed, and a solid brick pillar built in the centre of each furnace tube. At the junction of the furnace tube with the combustion chamber, a perforated brick diaphragm wall was built to secure uniform dispersion of the intense heat. The back of the lower part of the combustion chamber was protected by brickwork from direct impingement of the flames. The results of a six hours' test were as follows: Water per pound of oil from and at 212 degrees Fahrenheit, sixteen and one-tenth pounds; water evaporated per square foot of heating surface from and at 212 degrees Fahrenheit, nine and nine-tenths pounds; efficiency of boiler, neglecting steam used for burners, eighty-four per cent. During the whole test no smoke was emitted from the chimney. Subsequently a short test of three hours' duration was made to ascertain the maximum evaporation which was possible with such a boiler when oil-fired, without producing smoke. The test showed that it was possible to force the evaporation up to 18,900 pounds of water from and at 212 degrees Fahrenheit per hour under these conditions. The evaporation was at the rate of fifteen and eight-tenths pounds of water per pound of oil from and at 212 degrees Fahrenheit. —*Mechanical Engineer* (London), October 11.

A Town Heated by Electricity.

Electric heating has such advantages over the use of fuels for this purpose that it has been decided to heat in this way the sanitariums of Davos-Platz and Daive-Dorf, in Switzerland. A study of the locality has shown that sufficient water power can be had, and this article contains a discussion of the probable consumption of energy for heating, cooking and other work at these establishments. The principal reason for adopting this system was to avoid all smoke or contamination of the air in this locality. The two settlements cover a district about three kilometres long and from 300 to 400 metres wide. There is about 3,000 fixed population, and during the winter, 2,500 patients. The heaters are of two types, the first being merely a resistance covered by a suitable enamel. The second type, which is used principally for cooking, consists of a small alternating-current transformer which induces local currents in the base of the cooking utensil itself. The estimates of the energy required for the whole settlement allow 185,000 horse-power-hours for heating, and 53,600 for cooking. In addition to this, 9,550 horse-power-hours for bakeries, 15,000 for the laundries and 5,000 for the baths are allowed, making a total of 268,150 horse-power-hours per day of winter. Dividing this by 24 shows that the installation should have a capacity of 11,200 horse-power. These figures are criticised by Mr. A. de Grandmaison, who goes on to show that the estimate for cooking is very much too high. That for heating the buildings gives about 253 watt-hours per cubic metre of apartments, and is assumed to be correct. The results obtained at the restaurant during the exposition of 1900 show that an expenditure of about 450 watt-hours per meal was sufficient. The conditions existing at Davos are less exacting than were those at the exposition. It is thought that an allowance of 1,250 watt-hours per day per person would not be far from the truth. Assuming this figure, the total as given above will be reduced to 228,000 horse-power-hours, and a plant of 9,500 horse-power should be sufficient. This power can be obtained from two streams—the Landwasser and the Albula, situated at about twenty kilometres from Davos, and having a fall of 394 metres. The central station will contain five sets of 3,000 horse-power each. Each turbine will be coupled directly to two three-phase alternators of 1,500 horse-power each. The alternators generate a potential of 8,000 volts, and two being coupled in series give a pressure of 16,000 volts, which is sent out over the line. The annual expense of this service, including interest, depreciation and cost of operation, is estimated at 829,528 francs. The consumption of energy for the year will be 25,000,000 kilowatt-hours, so that the price per kilowatt-hour will be 3.3 centimes. This cost is not regarded as excessive for heating, while the advantages of its use for cooking, and the avoidance of all smoke, are more than sufficient to warrant the undertaking.—*L'Electricien* (Paris), October 4.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Electrically-Driven Notching Presses.

The accompanying illustrations show several of the applications of motors to large machines which find constant service in the manufacture of electrical apparatus. Fig. 1 is a press which is driven by teeth cut in the flywheel, which engage with a pinion on the motor shaft. This form of direct driving is very often used, and is claimed to be more positive and rigid than when a press is belt-driven from the motor. This press is adapted for large sizes of armature discs up to about twenty inches in diameter and, as may be seen from the illustration, has a number of special features, the sliding ram being unusually long, with wide bearing, which ensures accuracy for the emplacement of the dies. The machine is also provided with an improved form of clutch, clutch lock, treadle lock, and a self-oiling device for the flywheel clutch. This press is also made with an open front, and this is sometimes preferred, as the discs can be cut from the sheet and the sheet fed in from right to left or from front to back, as desired.

Fig. 2 is a geared punching press, arranged with the motor set on an adjustable shelf, and driven by a belt from the motor to the press. For many kinds of work it is desirable to drive with a belt, as there is less vibration of power communicated to the motor, the belt giving a flexibility which is hard to obtain when the motor is geared directly to the flywheel. This punching press is especially adapted to electrical instrument work of various kinds, and has a number of good features in the adjustment of the ram and clutch.

The Ferracute Machine Company, Bridgeton, N. J., is the manufacturer of a large number of different styles of machines and machine tools, especially adapted for work in electrical industries. These are constructed for both direct and belt driving from electric motors, and also for steam-driven connection.

Fig. 3 is an illustration of what at the present time seems to be a novelty in machine construction. This is the invention of Mr. Oberlin Smith, of the Ferracute Machine Company, and is described as an "electric boy." This company turns out a large number of presses of all kinds, and in order to ensure accuracy and durability of the parts, each machine is subjected to a running test covering about ten hours before shipping. It has been found necessary, therefore, to employ three or four boys each day to keep the machines working under test, particularly those machines which have to make intermittent strokes, by depressing the toe treadle in some cases as many as 10,000 times during ten hours. This would require constant attention, and has been a source of great expense and does not give the satisfaction that is required. The machine illustrated consists of a frame or truck, mounted on four small wheels, on which is mounted a bicycle frame with a sprocket chain, etc., driving a geared wheel in the usual manner. There is also mounted in connection with this, and on the same platform, a lever and treadle, and the motion of the sprocket wheel being communicated to the lever, that is given an intermittent up and down movement, which is just what is wanted to start the treadle press and put the machine in motion. The whole mechanism is driven by a small one-eighth-horse-power motor, a cord or belt running from the motor to the rim of a large flywheel. The machine was built for experimental purposes, and the bicycle frame seemed to be a very favorable aggregation of parts to use in connection with it. The handles are placed in position so that the whole truck can be wheeled up in front of the press, and the machine merely stands where the operator would naturally stand. If desired, three presses can be

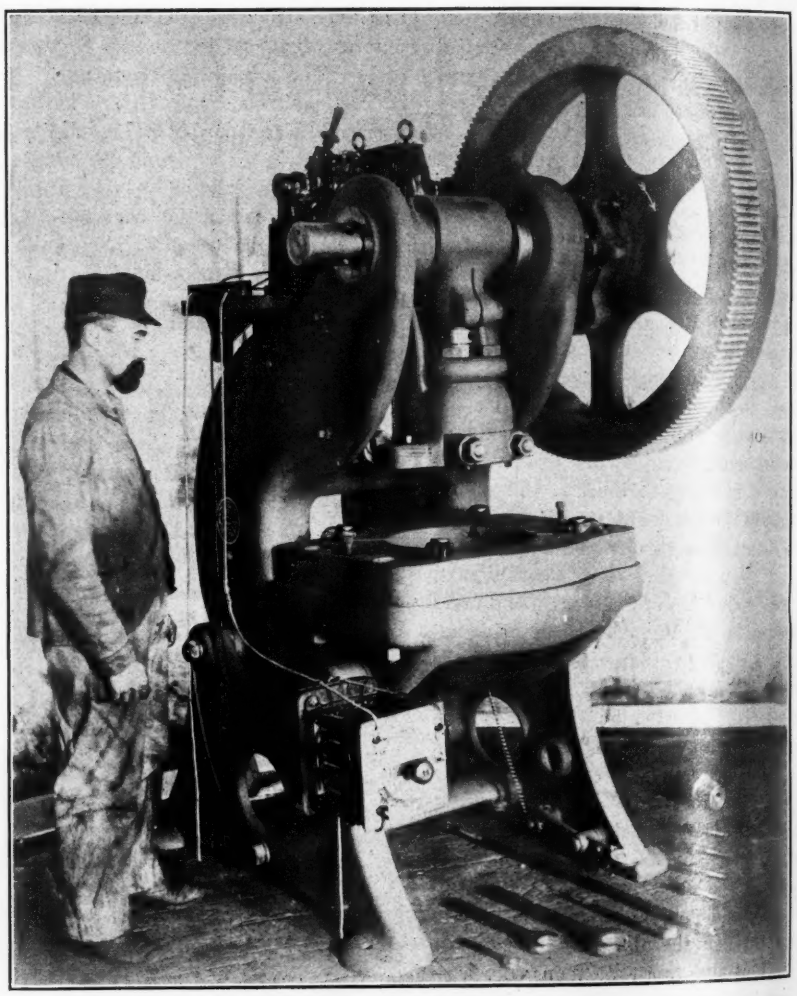


FIG. 1.—ELECTRICALLY-DRIVEN PRESS, MOTOR PINION ENGAGING IN TEETH CUT IN FLYWHEEL.

placed in a row, with a piece of board resting on all three treadles, and the lever will then operate three presses as well as one. This electric boy can be arranged to manipulate almost any machine where a treadle motion is desired and where the power is applied through a treadle to stop or start the machine.

A Quick Repair Job.

The Massachusetts Chemical Company recently received the following story of rapid repair work from a young factory electrician located in western New York.

"The proposition which faced us was a sixty-horse-power, 500-volt, direct-current motor which had given a good deal of trouble, as it had been insulated with supreme indifference to common sense. The armature coils had been dipped once in shellac, baked, dipped in linseed oil varnish, baked again, assembled and painted with some black varnish. The fields had been dipped in black paint, baked, taped with strips of duck, shellaced and finally painted black.

"The persistent leakages in the armature we had taken care of by frequently heating it with the current and then dipping it in Armalac. On several occasions we took care of short-circuits which had been caused by chafing of the crossed windings by lifting the wire slightly and jamming in a bit of cotton waste which had just been saturated with Armalac.

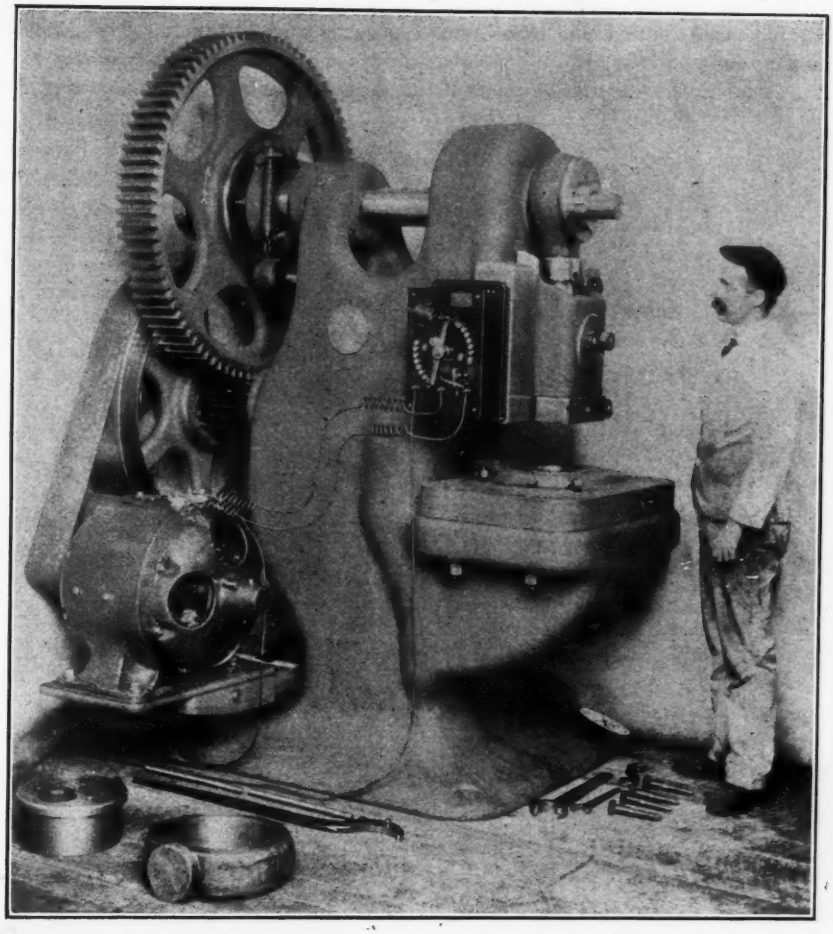


FIG. 2.—GEARED PUNCHING PRESS, DRIVEN BY BELT FROM MOTOR SET ON SHELF.

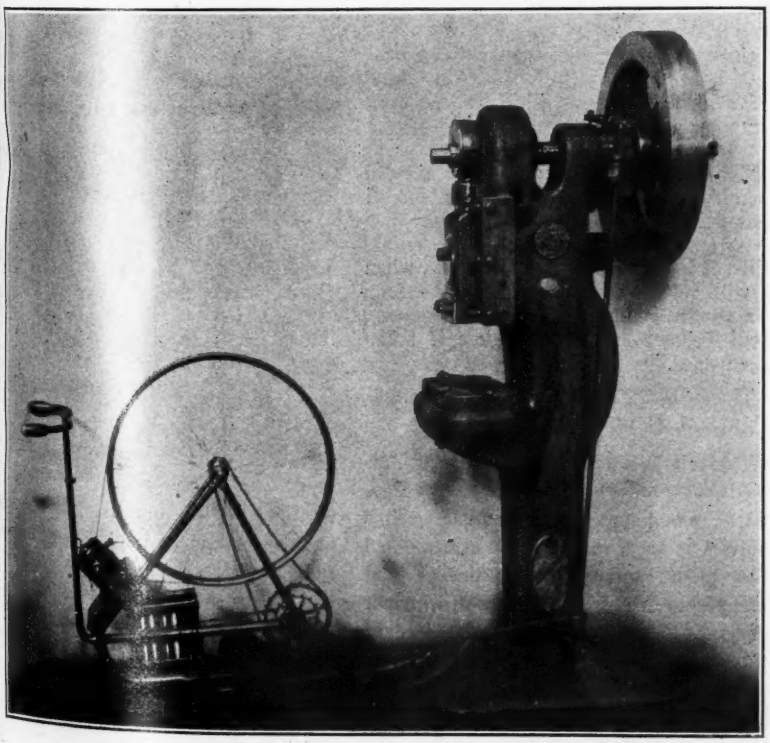


FIG 3.—"ELECTRIC BOY," FOR TESTING PURPOSES.

"In the present instance, under the expansion of a heavy overload, one of the binding bands burst and before the machine could be stopped the armature and four fields were badly smashed.

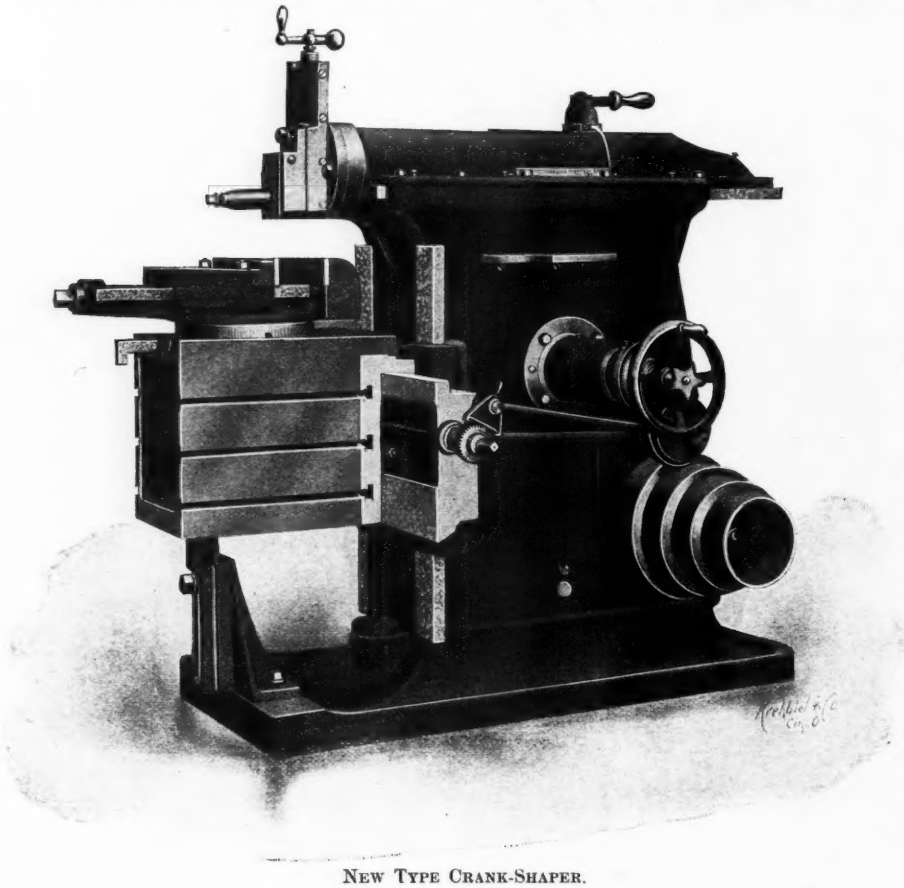
"Export orders were behind, transatlantic cables were demanding immediate deliveries and the cessation of work by that machine meant idleness for $75,000 capital and fifty operatives.

"The smash occurred at 2 P. M., and, by a hasty consultation, the factory committee decided that, as the sending of the repair job to a repair shop would entail a delay of at least a week at an expense of $200 and a net loss of at least $1,000, it would take a chance and try to patch up the machine as it stood. The factory joker announced that if we did it we would have a 'patch' instead of a motor.

"Armature and fields were quickly removed, two men detailed on each piece and the work of stripping the fields begun.

"The armature abrasions were mended by prying out the coils and covering the denuded wires with the very thinnest of

Armalac tape, cut on the bias. It was 'puttering' work, but at one o'clock the next morning all the breaks were covered and tested out O. K. with the current.



NEW TYPE CRANK-SHAPER.

The armature was then set back on its bearings and the new bands put in place, turning the armature by hand. A pail of water resistance had been got ready long before and the juice was jammed through her until she was ripping hot. Then on wooden horses we turned her over and over with one-third of her diameter in a soap box (made temporarily tight with shellac and sand) and full of Armalac. The old windings sucked up the insulating material as a blotter soaks up ink, and the operation was continued until the armature was nearly cool. Then the soap box was taken away and the slow turning continued (to make the compound dry in an evenly distributed state) until the fields had been put in position.

"The work on the fields had been of an especially exasperating character. They were of small wire, and at least a dozen wires on each field had been smashed. Long and 'puttery' was the job of soldering them and putting each one into a little trough of fine Armalac tape. Then they were heated with the current and sent into the dipping tank. Then wound with thin bias Armalac tape, painted with Armalac, wound with thin bias Armalac duck one and three-quarters inches wide, and again painted. At a quarter of five we started up the machine, left it running under the eye of the night man, and went home in the gray dawn with a consciousness of duty well done by comrades and employers which more than compensated for weary eyelids and aching backbones.

"The 'patch' is running yet, though there is a swelling like a spavin on all four fields. The rush orders are filled, a heavy expense bill avoided, and the 'patch' will not be disturbed until January, when it will get another baptism in the soap box on the general principle that 'spring medicine' accomplishes wonders if taken in advance."

A New Crank-Shaper.

The crank-shaper shown herewith is the latest product of the American Tool Works Company, of Cincinnati. This shaper is a thoroughly modern tool throughout, and is much heavier and stronger in every way than former models. The column is of unusual depth and width, tapering slightly from base to top, adding to the solidity as well as the graceful appearance of the machine. The base is of extension type, and the ram has long, wide bearings in the column, with improved oiling facilities. The table, cross-rail, etc., have all been given additional dimensions and weight, thus giving the machine, as a whole, a greatly increased power and capacity, yet retaining a well-proportioned, compact appearance. The stroke is positive and the length may be changed at will without stopping the machine. The index shown on the ram facilitates the setting of the stroke to the length desired. The rocker arm is pivoted near the base line, and this gives the ram an almost uniform rate of speed for its entire stroke and provides an exceedingly quick return. The back-gear ratio is the highest employed on any shaper of to-day, and gives this tool an exceptional power in taking heavy cuts. The rocker arm is of double-section pattern permitting a large-sized shaft to be passed under the ram, through the hole shown in the top of column, for key-seating.

This shaper is convenient, easy and smooth in operation, and is susceptible of fine and positive adjustments while under full speed, giving it especial value in the exacting requirements of the tool-room, and the line of sizes embraces sixteen-inch, single-geared; sixteen-inch, eighteen-inch, twenty-one-inch and twenty-five-inch, back-geared.

Printing-Press Controllers.

The printing-press controller shown in the accompanying illustration has been designed with special reference to the elimination of injurious sparking upon the contact. The maker of this apparatus has, owing to its special construction, been able to afford a sufficiently large number of steps in the resistance

PRINTING-PRESS CONTROLLER.

so that the electromotive force developed at the contacts is kept at a point below that at which the arc can be produced.

The resistance of these different controllers is designed in two sections. The section first cut in circuit has capacity for the full torque current of the motor continuously applied. When this section is the only resistance in circuit, the motor will be running and developing counter-

volts. The insertion of all this section of resistance will stop the motor under conditions of full torque, because the ohms are sufficient to cause the drop of the full-line volts when the full torque current has passed through it; that is, by the time all of the resistance of this first section is inserted in the circuit under conditions of full torque, the motor will necessarily be at rest since the entire line electromotive force will be dropped upon the resistance, and hence there will be no electromotive force upon the armature terminals of the motor.

At this point is begun the insertion of the resistance of the second section of the controller. It will be evident that as each additional step of the resistance is inserted when the motor is at rest, the current will be gradually reduced as in the case of a field rheostat or theatre dimmer. The purpose of this second section is to introduce into the circuit a sufficient amount of resistance to stop the motor even if it be operating under conditions of merely friction load. The ampere capacity of the succeeding steps of resistance is gradually tapered from the full torque current of the motor to the friction-load current. The resistance of each successive step is such that it is impossible to produce an arc at the contacts and the current capacity at each step is sufficient to carry continuously the maximum current to which it can be possibly subjected.

The multiple unit system of construction is employed; that is, for each two and one-half horse-power motor capacity, there is a unit controller complete with resistance, contacts and contact lever. The unit controllers are assembled in bank to secure any horse-power duty, the controllers being connected in multiple and all four levers being operated by one shaft common to all. By this arrangement there is no limit to the size for which a controller can be made by assembling the unit controllers in bank.

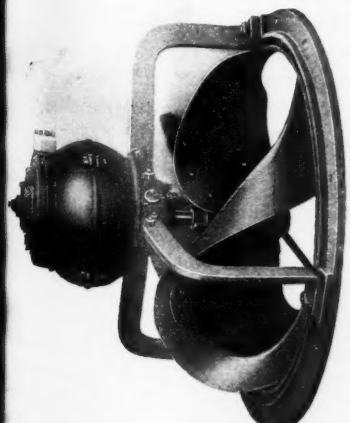


FIG. 2.—MOTOR DIRECT DRIVING SMALL VENTILATING FAN.

These controllers are manufactured by the Ward Leonard Electric Company, Bronxville, N. Y.

Propeller Fans.

The accompanying illustrations show the latest developments of the Davidson propeller fan. This fan is well adapted to nearly all operations of ventilation, heating and drying. In the drying of lumber, textiles and other materials, it is successfully used in connection with a sectional hot-blast heater. Nearly all drying operations require the movement of large quantities of air at comparatively low pressures, although this fan may be successfully used against pressures of three-eighths to one-half ounce per square inch.

For ventilating work of every description, this fan is claimed to offer peculiar advantages. Ventilating operations, and in the removal of gases, vapors, it is claimed to move large volumes of air quietly and with the minimum expenditure of power. The form of the blades of the Davidson fan is said to ensure this, while the entire construction is such that the apparatus can be run continuously without unusual attention. The frame consists of both wrought and cast-iron parts, carefully machined, fitted and bolted together in the most rigid manner. The bearings are connected to a heavy cast-iron wall ring by wrought-iron bars, ensuring rigidity and alignment. These bearings are of cast iron with a large oil reservoir cored in the required half, which holds a sufficient quantity of oil to run the fan several days without attention. In smaller sizes, the oil is fed to the bearings by wicking. The bearings

FIG. 3.—ELECTRIC MOTOR DRIVING STEEL BLOWER.

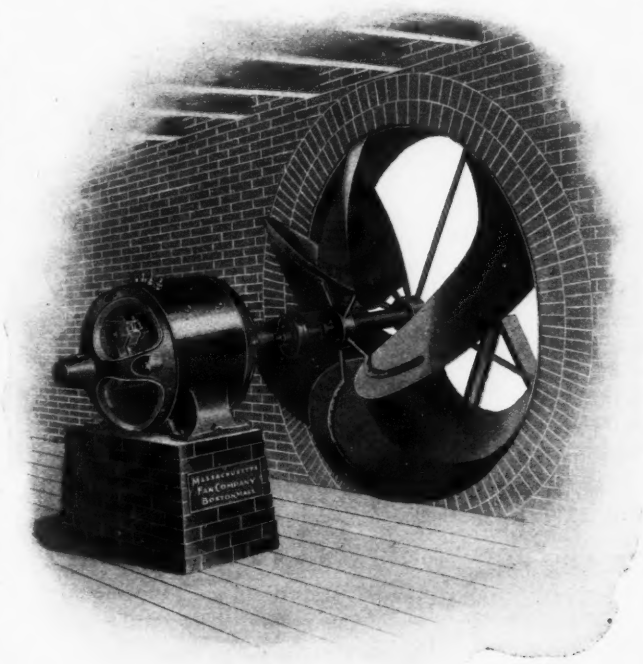


FIG. 1.—MOTOR ON SEPARATE BASE FOR DIRECT DRIVING LARGE VENTILATING FAN.

are lined with the best quality of babbitt metal, which after casting is hammered and reamed to accurately fit the shaft. The cap is attached to the lower end of the bearing by four cap screws which provide considerable adjustment to compensate for wear. The blades are compound curved and so designed to pick up the air at a very low velocity and deliver it at a comparatively even pressure over the whole surface of the fan. The blades may be built of cold rolled copper or of a composition commonly called "yellow metal," or the entire runner may be of steel. Fans with composition or copper blades are well adapted for use in dye houses, bleacheries and sulphite mills, or in any location where they are required to handle air or vapor containing gases likely to corrode fans with steel blades.

These fans are adapted for driving by direct-connected electric motors, and in this way applicable to all sources of ventilating work in public and factory buildings, and for the removal of heat and moist air in prominent use for manufac-

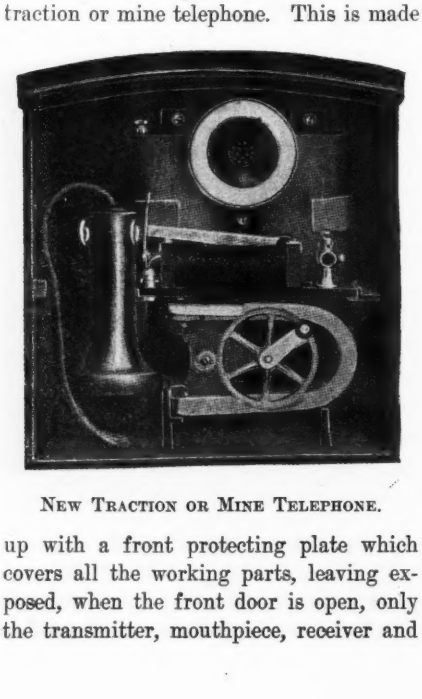
turing and drying, and for the circulation of heat or cold air for the purpose of heating or cooling. Motors are made in several styles suitable for fans from 12 inches to 120 inches in diameter. The motors required for fans above forty-eight inches in diameter have to be separately supported from the fan ring owing to the considerable weight thereof. An illustration of this description is shown in Fig. 1. The motors may be of the open, semi-enclosed or wholly enclosed type, and are wound for direct current in either of the three standard voltages, 115, 230 or 500 volts. Each outfit is provided with a plain or automatic fireproof speed regulating rheostat, of a size sufficient to reduce the revolutions of the fan to forty per cent from its maximum speed.

Fig. 2 shows the Davidson fan with direct-attached Lundell motor. The size of the fan ranges from eighteen to sixty inches, and the motor capacity varies from one-quarter to seven and one-half horse-power, the revolutions being 850 to 350, respectively. The capacity of these fans range from 2,600 to 39,400 cubic feet per minute.

Fig. 3 shows a steel blade electric fan, direct attached to either a direct or alternating-current motor. The sizes of these fans range from 40 inches to 280 inches, and have a very wide application. These propeller fans are manufactured by the Massachusetts Fan Company, of Waltham, Mass.

Traction or Mine Telephone.

In the accompanying illustration is shown the latest product of an iron box traction or mine telephone. This is made



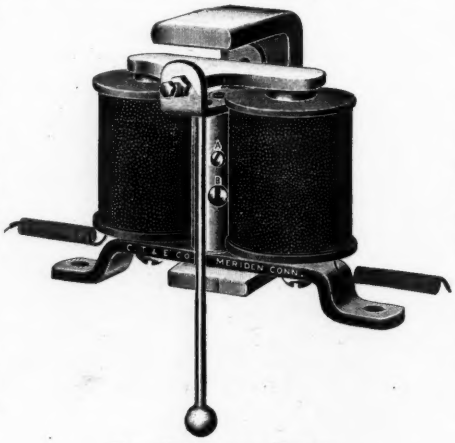
New Traction or Mine Telephone.

up with a front protecting plate which covers all the working parts, leaving exposed, when the front door is open, only the transmitter, mouthpiece, receiver and generating crank. The illustration does not show this protecting plate, which is made up with a rubber gasket. The manufacturer believes this to be one of the most complete iron box telephones ever placed on the market. It is made up with ringer coils with various resistances as desired. These ringer coils either cut in all of the time or cut out when the outside door is closed, leaving, of course, the line perfectly clear.

This type of telephone is especially adapted for outdoor use, being thoroughly damp and moisture-proof. It is equipped with moisture-proof transmitter, pure hard rubber shell receiver and powerful generator. The cast-iron box is further provided with a heavy lock, and the whole fastens to the pole with lag-screws from within. This is manufactured by the American Electric Telephone Company, of Chicago, Ill.

New Telephone Ringer.

In designing this ringer, the principal object in view is to overcome the objec-



New Telephone Ringer.

tionable features in the adjusting of ringers of this nature. This operation has to be repeated, in a good many cases, several times before the proper adjustment is secured. In the ringer shown here this serious objection is claimed to be entirely obviated by simply using a beveled screw.

The frame of the ringer is made of soft sheet iron bent into form. On the centre of this is mounted a barrel or supporting post, into which fits the plunger carrying the armature. It will be noticed by referring to the illustration that there are two screws in the barrel, marked A and B. A is simply a set-screw which prevents any possibility of the shifting of the plunger. B is the adjustment screw, which is screwed in to draw the armature near the pole of the magnet, and screwed out or unscrewed to throw it away from the poles of the magnet. With this arrangement it is possible to adjust the ringer with a pocket-knife or a screw-driver. After once adjusting, there is no chance for variation, and the change can be accomplished in the fractional part of a minute. The magnet cores on these ringers are made up of the best grade of imported Norway iron that it is possible to secure, and the cores are wound with silk insulated wire. The armatures are made of a high grade of Norway stock, carefully annealed and polished; then the armature is blued and coated with gun barrel lacquer, which prevents any possibility of its rusting, even if wet with salt water. This combination makes an excellent ringer.

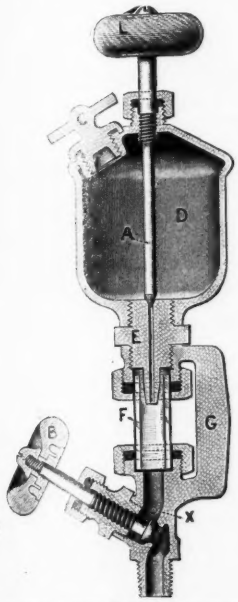
It has been submitted to a number of telephone experts, and in every case it has been endorsed for its simplicity and efficiency. It is made by the Connecticut Telephone and Electrical Company, Meriden, Ct., and carried in stock, wound to 80, 1,000 and 1,600 ohms resistance and can be made up for any resistance desired.

An Apparatus for Lighting Miners' Safety or Other Enclosed Lamps by Electric Current.

At a recent meeting of the Midland Institute of Mining, Civil and Mechanical Engineers, Mr. E. Brown described an apparatus for lighting enclosed lamps. Without some such device, about two hours are required to light all the lamps by hand. This is not only tedious, but expensive. Other devices for this purpose have been constructed, but have all necessitated a considerable change in the shape of the lamp. This apparatus consists of an induction coil having the terminals of the high-pressure secondary connected to a base-plate and a movable contact piece. This movable contact piece when pressed backward, closes the primary circuit. The glass chimney of the lamp has rivetted into the side a copper electrode, which approaches close enough to the burner for a high-potential spark to jump the gap. When a lamp is placed upon the base-plate and the copper electrode brought in contact with the movable secondary terminal, and the lamp pushed back sufficiently to close the primary circuit, sparks will pass between the electrode and the burner and light the lamp. The apparatus is intended to be taken into the mine or to any convenient lamp station, and is locked up so that only the properly appointed person can relight any lamp which may have been extinguished. Lamps in the lamp cabin can be lighted as they stand by running two wires along the shelves, one so as to be in contact with the base of the lamp, and the other with the copper electrode.

An Automatic Sight-Feed Graphite Lubricator.

With the growing tendency among steam users generally toward high pressures and superheated steam, the use of oil as a lubricant has given more or less trouble. Powdered graphite has for some time been advocated by a great many engineers as a good lubricant, it having the quality of being adapted to be forced into the superficies of the cylinders and valves of steam pumps and engines due to the



Graphite Sight-Feed Lubricator.

motion of the moving parts giving a highly finished surface, thus reducing the friction and requiring very little oil. While graphite possesses high lubricating qualities, at the same time it is not always advisable to use it alone, and it is deemed good practice to use this in connection with some liquid form of lubricant. In the accompanying illustration is shown a sectional view of an automatic sight-feed lubricator which is claimed by the manufacturers to be meeting with great success for this service. The graphite is fed automatically and continuously in desired quantities, and this is always visible by passing it through a sight-feed. The cup requires but one connection to the cylinder, is very simple in construction, compact and in appearance is anything but unsightly. This lubricator is always placed on the steam chest. On slide-valve engines, it is only necessary to use one cup, placing it about the middle of the steam chest; but on the Corliss engines it is best to use two, placing one over each valve.

The operation of this lubricator is essentially as follows: The steam valve is closed at B and the drain plug X is opened to allow the steam to escape from the cup, then the regulating valve L is closed. The filling plug C is removed and the cup is filled with graphite. After replacing the filling plug, the drain plug is closed and the steam valve is opened wide, the feed of graphite being adjusted by the regulating valve. The sight-feed closed can easily be cleaned by opening the drain plug. If necessary to replace the sight-feed closed, the cup may be taken apart by means of the lock-nut E and a new glass slid down through the opening.

This automatic sight-feed graphite lubricator is manufactured by the Lunkenheimer Company, general offices and works being at Cincinnati, Ohio.

New Telephone Apparatus.

The accompanying illustrations show a new line of battery call telephones for intercommunicating and hotel use. The desirability of telephones for interior use is very generally recognized, and a telephone that is not only highly efficient but has the additional

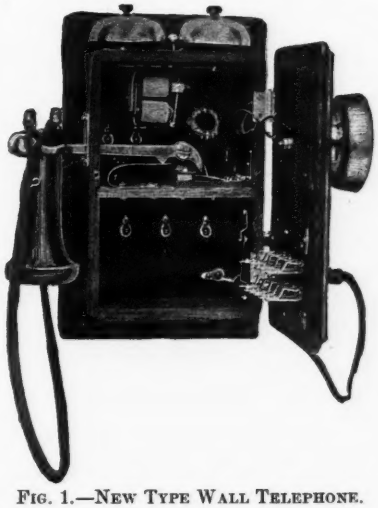


Fig. 1.—New Type Wall Telephone.

quality of durability is readily sought for in the equipment of an up-to-date business house. The manufacturer of this line of apparatus claims for it among other features, being perfect in mechanical and electrical construction and obviating entirely cross-talk if properly installed. The plugs can be left in jack without disturbing the station.

Fig. 1 is interior view of the new type of wall telephone. Fig. 2 is another type of wall telephone, and Fig. 3 is an interior view of a battery telephone for two stations only, or for hotel use in connection with annunciator. These telephones are equipped with long-distance, solid-back transmitters, with heavy metal case, imported granulated carbon and gold electrode. The gravity hooks are made with German silver and are equipped with lever springs, no spiral springs being employed. The bells are of five ohms resistance. The jack-spring contacts are made of platinum and German silver.

Fig. 2.—New Type Wall Telephone.

No induction coils are used, but all the instruments are furnished with non-inductive resistance coils. No local batteries are used, both ringing and talking power being furnished with one set of

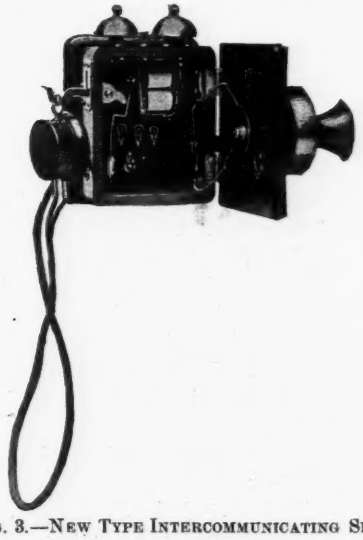


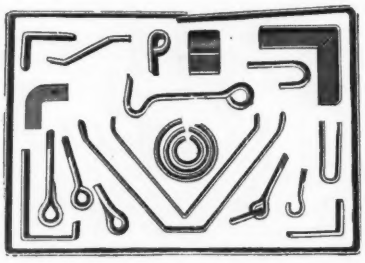
Fig. 3.—New Type Intercommunicating Set.

batteries. These instruments are made by the Central Telephone and Electric Company, St. Louis, Mo.

The absorption of small quantities of nitrogen by pure iron renders it hard and brittle like steel.

Bending Tools.

The accompanying illustration gives a very good idea of the wide range of angles and eyes which is possible with the angle and eye-bender manufactured by the Wallace Supply Company, Chicago, Ill. These bending tools have a constant application in almost every variety of mechanical metal working. Ease and quickness of adjustment, simplicity and rapidity of operation, and wide range of adaptability are the main points of advantage which render these tools especially valuable. Any blacksmith or helper can operate them, and expert attendance is in no case called for. Both the angle and eye-benders are secured removably to brackets which may be fastened to the forge frame or placed in any other location in the shop convenient to the operator.



Angles Made with Bending Tools.

Joint Session of Independent Telephone Associations.

The fourth annual meeting of the Kentucky Independent Telephone Association and the third annual meeting of the Southern Indiana Independent Telephone Association are being held this week at the Board of Trade Building, Louisville, Ky. The joint quarters of the convention are at the Louisville Hotel. The programme as announced includes an address of welcome by the Hon. C. H. Grainger, Mayor of the city of Louisville, the response to be made by the Hon. W. C. P. Breckinridge, representing the Kentucky Independent Telephone Association, and the Hon. G. A. Keinle, representing the Southern Indiana Independent Telephone Association.

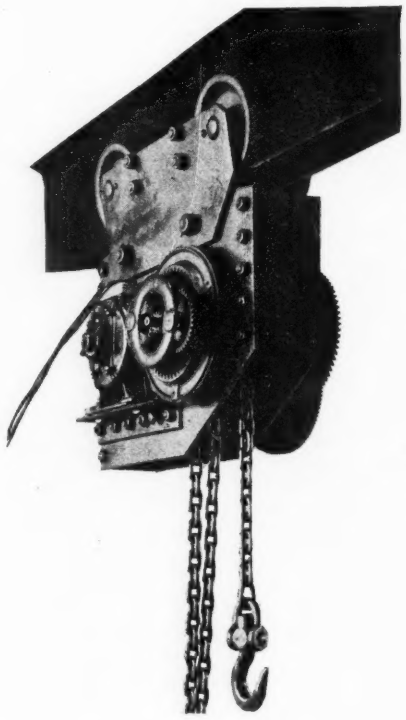
The following addresses have also been arranged for:

"National Association," Hon. S. P. Sheerin, Indianapolis, Ind.; "Long-Distance Toll Lines and Connections," H. K. Cole; "The Bell People as Antagonists," A. J. Payton; "Franchises," Colonel John R. Allen; "Rates," P. L. Pendleton; "Interstate Association," E. M. Coleman; "Merging of Independent Telephone Plants," J. S. Brailey; "Operating and Governing Telephone Plants," A. L. Tetu.

There will be the regular business meetings of the two organizations, and the members of the associations will be the guests of the board of directors and officers of the Home Telephone Company, of Louisville.

An Electric Trolley Hoist.

The accompanying illustration shows an electric trolley block which is manufactured by the Brown Hoisting Machinery Company, Cleveland, Ohio. These are built in five sizes, from one to five horse-power, the illustration showing one of three tons lifting capacity. These are made for hoisting by electric power only, or for hoisting and travel by electric power. The hoisting mechanism used is the well-known Yale-Weston triplex block.



Electric Trolley Hoist.

Local Pittsburg Institute Meeting.

At a meeting of the local members of the American Institute of Electrical Engineers, held Monday evening, October 13, a committee consisting of P. M. Lincoln, Professor S. M. Kintner, C. W. Rice, J. S. Peck and F. B. Erwin, was appointed to call a second meeting, provide a programme therefor, and to propose a plan for a permanent organization of Pittsburg, Pa., members.

The committee decided to accept the invitation of the Electric Club, an organization made up chiefly of engineering apprentices, to hold the next meeting in their hall in Wilkinsburg, Pa., on Thursday evening, November 6.

The members of the club were in turn invited to attend these meetings and to take part in the discussions.

It was decided to take up for discussion the general subject of illumination. Professor Kintner, of the Western University of Pennsylvania, is to give a résumé of the papers presented at the general meeting, and Mr. Scott will give a summary of the New York discussion. Mr. Wurts will be asked to discuss the general topic of the evening—illumination. Although no definite arrangements have yet been made, it is expected to have a talk also on the Nernst, Bremmer flame-arc lamp, and on the Cooper-Hewitt lamp by gentlemen who are more or less familiar with these subjects. Acetylene lighting, indirect electric lighting will also receive a share of attention. It is also proposed to illustrate the remarks by exhibitions of the lamps themselves. A Nernst lamp, a Bremmer arc lamp, a Cooper-Hewitt lamp and an acetylene gas-light will be exhibited in the hall during the evening. The stated communications will be restricted to not over ten minutes each, and the subject will then be thrown open to general discussion.

As to permanent organization the committee will recommend that an executive committee of five, consisting of a chairman, a secretary and three other members, be elected at the meeting of November 6, to take full charge of this local section, including the calling of meetings, the preparation of papers, etc.

Soo's Big Power Canal Open.

Water was turned into the new power canal of the Consolidated Lake Superior Company, at Sault Ste. Marie, Mich., Saturday morning, October 25, and at twelve o'clock noon Miss Helen Clergue, sister of Francis H. Clergue, organizer and general manager of the company, turned a jeweled switch that started the wheels in the big power-house.

Miss Clergue started the machinery and set the wheels in the power-house whirling for the first time. The first current generated was used to run one of the company's new electric street cars.

A civil and military parade marched through the streets during the morning. It exceeded anything ever seen in upper Michigan. Over 10,000 men were in line. During the afternoon an industrial parade was given, which showed the different products of the Clergue institutions in the various stages from raw material to finished production. On Saturday evening the three days' celebration ended with a banquet in the armory.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

NEW MANILA ENTERPRISE—The Philippines Commission has passed a bill providing for the construction of a Standard Gauge Electric Railway for a lighting and power plant. The bids will be opened at Manila on March 5. Specifications will be exhibited in Manila and Washington.

SOUTH AFRICAN WATER-POWER PLANT—It is announced that some $1,200,000 is to be expended in the carrying out of a South African water-power project. The water is drawn from the Maguadzi River. The initial capacity will be 1,400 horse-power. The electricity will be utilized for supplying the mines in the vicinity with power for operating machinery, etc.

MEXICAN ELECTRIC TRACTION SYSTEM—Contracts will shortly be placed in the United States for the equipment of seventeen miles of electric traction which is to be constructed in the city of Monterey, Mexico. The contracts will aggregate about $1,000,000. Two of the principal existing horse-car roads are to be converted into electric motive power, and a new short line will be built, the concession for which has been acquired by an American engineering and contracting firm.

TEN MILLION DOLLAR DEED OF TRUST—A deed of trust to secure a bond issue of $10,000,000, given by the Union Electric Light and Power Company, has been placed on record in the office of the recorder of deeds, St. Louis. The Mississippi Valley Trust Company is trustee. The deed covers the property of the Union Electric Light and Power Company. The frontage of the property is 142 feet 6 inches. The personal property is also included. The bonds run for thirty years and bear interest at the rate of five per cent. They are payable in gold.

MAINE ELECTRICAL SYNDICATE FORMED—A syndicate of Boston and New York men has undertaken the generation of electrical power by utilizing the water of Union River, Maine. It has been concluded that 40,000 horse-power can be generated there and transmitted as far as Bar Harbor and Bangor. Contracts have already been signed by Ellsworth manufacturers, who will take 40,000 horse-power, and negotiations are in progress with the Eastern Manufacturing Company at Bangor, and other large concerns. The directors have organized a corporation of $1,000,000 and propose to construct a main dam at Ellsworth, Maine, and another twelve miles above.

ILLINOIS REORGANIZATION PLAN—A deal involving $2,000,000 is in progress, the parties being the members of the Springfield Consolidated Street Railway Company and the Springfield & Central Illinois Railway Company. This is practically a reorganization of the street-car business of Springfield in such a way as to include the interurbans projected by interest of the local railway company. The idea is to transfer the property of the Springfield Consolidated Street Railway Company to the Springfield & Central Illinois Railway Company. To do this and carry out the plans of the latter company will require two and one-half million dollars which will be raised by a bond issue.

ELECTRIC POWER DEAL—It has been announced that the Highland Canal and Power Company, of Duluth, Minn., has secured an option on the St. Louis River rapids and will control all the water available for power purposes at the head of the lakes. It is stated that something like 50,000 horse-power can be developed under the combined systems. The first installation will be completed about a year from next spring, and the company is now contracting to deliver electric current in Duluth and Superior not later than June 1, 1904. Electric current will also be transmitted to the mines and range towns. The available fall under the Duluth Heights system is 7,740 feet and the available fall under the St. Louis River Rapids development is 370 feet.

VICTORY FOR MR. YERKES—The contention made by council for Charles T. Yerkes before the House of Commons Railroad Committee last week that the bill providing for the construction of a Piccadilly and City Road must be withdrawn, as the Morgan's tube scheme had no legal status, through having been presented to Parliament as part of the United London plant which has become non-existent through the withdrawal of its bill, has been upheld by the committee. The chairman, Sir Louis McIver, announced that the committee was unable to proceed with the consideration of the bill. It is understood that the Morgans do not propose to abandon their underground projects. In spite of the decision of the committee, they will have a bill introduced in 1903 giving facilities similar to those of the scheme just quashed by the defection of the London United, control of which was purchased by Speyer Brothers, who are financiers of Charles T. Yerkes's plans.

GAS AND ELECTRIC COMPANIES IN EXTENSIVE MERGER—Negotiations are under way for the consolidation of a number of gas and electric lighting companies now operating as independent concerns. It is probable that an operating company will be formed to acquire ownership of a number of properties, the most important of which are the New York & Queens Electric Light and Power Company, the Newtown & Flushing Gas Company, and the Williamsport, Pennsylvania, Gas Company. The New York & Queens Electric Light and Power Company does practically the sole electric lighting business in the Borough of Queens. The preferred stock authorized and issued is $1,250,000, and the common stock is $1,250,000. This company also controls the Newtown & Flushing Gas Company, and is capitalized at $1,300,000. The Williamsport company was incorporated nearly fifty years ago. The directors are almost identical with those of the other two companies, and its capital stock is $350,000.

PERSONAL MENTION.

MR. F. S. TERRY, secretary of the National Electric Lamp Company, was a New York visitor last week. Mr. Terry, whose interests require his presence in New York, Cleveland, Chicago and St. Louis, about equally, has become known as one of the most indefatigable travelers in the electrical field.

MR. L. G. MARTIN, the cable-laying expert of the Okonite Company, left last week for San Francisco to superintend the laying of the land lines for the Pacific Cable Company at San Francisco, and also the land cables at Honolulu. This cable is expected to be in working order between Hawaii and United States in about sixty days.

MR. CHARLES CUTTRISS, chief electrician of the Commercial Cable Company, left Saturday of last week for San Francisco to superintend the technical details of the opening of the new cable between the United States and Hawaii. Mr. J. G. Gaines, of Canso, N. S., it is understood, will be the superintendent of this cable line, with headquarters at Hawaii.

MR. THOMAS E. MITTEN, it is stated, is considering a proposition which may place him at the head of the Metropolitan Street Railway Company, of New York, under President Vreeland, who, it is said, is contemplating a European tour, which will cover a considerable period. Mr. Mitten was formerly superintendent of the Milwaukee Street Railway System and is now general manager of the International Traction Company, of Buffalo, N. Y.

MR. P. A. RAMAGE has been elected honorary secretary of the Manchester section of the Institution of Electrical Engineers. Mr. Edward W. Cowan has vacated the post of honorary secretary and has been elected vice-chairman. Twelve ordinary general meetings were held by this section during the year just closed and a number of valuable topics received. These meetings were well attended, there being an average of over 100 members and friends present at each session.

MR. ANDREW C. SHAW, the London manager for the McGraw Publishing Company, reached New York on the steamship Campania, October 4, in time to attend the convention of the American Street Railway Association at Detroit, and is now continuing his American visit in New York. Mr. Shaw was prominent in electrical and publishing circles through his long connection as business manager of the *Electrical Engineer*, prior to its mergement. Since the consolidation of the *Electrical World* and the *Electrical Engineer*, Mr. Shaw has acted as the London representative for this publication, and also for the *Street Railway Journal*.

ELECTRIC RAILWAYS.

COLUMBIA, TENN.—The Nashville & Columbia Electric Railway has been granted the right of way on certain streets inside the city limits.

TUCKAHOE, N. Y.—The Interurban Railway Company has been granted a franchise for an extension of its trolley line on the White Plains Road to Waverly Square.

ANDERSON, IND.—The Richmond & Northwestern Electric Railway Company has begun the construction of an electric railway from this city to Middletown, nine miles southeast.

EASTON, PA.—The Easton & Nazareth Street Railway Company and the Easton, Tatamy & Bangor Street Railway Company have been consolidated, and hereafter will be operated as the Northampton Traction Company.

KNOXVILLE, TENN.—The Knoxville Traction Company will shortly extend its lines to Lonsdale, in accordance with franchises recently granted the company by the county court. It is expected that the work will be completed in a month.

DAVENPORT, IOWA—The board of supervisors has granted the Iowa & Illinois Railway Company permission for the construction of an electric road between this city and Clinton. Work is to begin within thirty days and be completed inside of two years.

PITTSBURG, PA.—Plans are being considered for the construction of a scenic railway along the Watching Mountains, from North Plainfield, N. J., to the mountain resort, Chimney Rock. It is proposed to connect the line with the Plainfield & Elizabeth trolley line.

ROCHESTER, N. Y.—An extension of the Buffalo & Depew electric road is to be built, passing through the towns of Lancaster, Corfu, West Batavia, Stafford, Le Roy, Caledonia, Mumford and Clifton, striking Rochester at Genesee street. The work will begin in the near future.

READING, PA.—The new trolley road connecting Allentown and Reading has been opened to the public. By this connection passengers will be able to go to Philadelphia, Trenton, Bangor, Doylestown, Slatington and several other important points in eastern Pennsylvania.

COLUMBIA, MO.—It is rumored that a company in which William H. Chase, of Toledo; E. W. Price, of Salisbury, and George B. Harrison, of Glasgow, are interested, will construct an electric railway through Linn, Charleston, Howard, Boone, Callaway, Montgomery, Warren and St. Charles counties.

MANSFIELD, OHIO—It is stated that W. J. Pentz, of Cleveland; John W. Giffin, of Mifflin, Ohio; Charles Miley, J. W. Galbraith and J. J. Maguire, of Mansfield, the projectors of the new trolley line from Mansfield to Ashland, will shortly incorporate under the laws of the state of New Jersey, with a capital of $300,000.

PORTLAND, ORE.—The Oregon City & Suburban Railway Company, which filed articles of incorporation a few weeks ago, is going ahead with plans for putting in a standard gauge electric road from Oswego to the western approach of the Oregon City bridge. C. D. Latourette, the banker, is president of the company.

DUNKIRK, N. Y.—The Dunkirk & Point Gratiot Traction Company has been reorganized, and it has been decided to construct a belt line around Dunkirk and extend the line to Buffalo. Luther H. Allen, Lattimer & Holcomb, W. J. Connors, Robert F. Schilling and Daniel F. Toomey comprise the new company. Surveys are already being made.

OAKLAND, MD.—Edward A. Sincell, representing Robert A. Ravenscroft, Marshall W. Wilson and others, has been granted a franchise for the building of an electric road through the streets of Oakland, and also for building an electric light and power plant. The franchise for the electric road covers a period of forty years, and the one for the lighting plant twenty years.

NEW BLOOMSFIELD, PA.—Surveyors are now at work laying out the route of the trolley line from Carlisle to Loysville, and the road will be rushed with all possible speed to completion. The new company has a capital of $120,000, which has been subscribed by local men. The line will extend from Carlisle, through Sterrett's Gap, Shermansdale and Landisburg, to Loysville.

SAN BERNARDINO, Cal.—The San Bernardino Valley Traction Company, which already operates electric roads in this city and Redlands, has applied for a franchise for an electric road from San Bernardino to Highland. The company states that it is its intention to connect all towns in this valley by electric roads, which would eventually be extended to towns lying between here and Los Angeles.

ALBANY, N. Y.—The Cross-County Railroad Company, with principal office in Brooklyn, has been incorporated to operate an electric surface road, fifteen miles long, between College Point and Willets Point. The capital of the company is $250,000, and the directors are: Joseph F. McClean, Andrew A. Halsey, Theodore Bernard, Charles H. Kelby, George F. Kellar, James Crowley, Francis Bacon, James Erwin and Charles Brandon, all of Brooklyn.

ALBANY, N. Y.—The Bull's Head & Annandale Beach Railroad Company has been incorporated with a capital of $250,000, to construct an electric road eight miles long in Richmond Borough from Bull's Head to Annandale Beach. The directors are: James W. Hughes, Harcourt Bull, Joardon M. Kroll, Charles William Kappes, A. E. Haskins, Hanford S. Weed, Joseph L. Doyle and Henry H. Cressman, of New York city, and David Murphy, of Jersey City.

CINCINNATI, OHIO—The promoters of the recently incorporated Cincinnati, Milford & Loveland traction road have organized with the following officers: B. H. Kroger, president; J. M. Wilson, vice-president; J. N. Roberts, secretary and treasurer. It was decided to issue bonds to the amount of $700,000, the capitalization of the road, which bonds are to be first lien on whatever assets the company owns. The company announces that it expects to have cars running into the city within a year.

ALBANY, N. Y.—The London, Aylmar & North Shore Electric Railroad Company, of New York city, has been incorporated with a capital of $500,000, to construct and operate an electric road with terminals in London, Port Barwell, Ontario, Canada, passing through Middlesex and Essex counties. The directors are: J. H. Hitchcock and J. E. Howard, New York city; Frederick Hitchcock and Frank Hassler, Detroit, Mich.; Cecil R. Lenton, Robert M. Lenton and W. A. Dorland, Grand Rapids, Mich.; W. A. Stephens and M. E. Lyon, Aylmar, Ontario.

GRAHAM, N. C.—The prospectus of the Graham, Burlington & River Falls Street Railway Company has been issued. This line will be twenty-one miles in length, connecting the towns of Burlington, Graham and Haw River, Swepsonville, Saxapahaw and River Falls, and will do both a passenger and freight business. The estimated cost is about $316,000. The capital stock is $100,000, and thirty-year bonds will be issued to the amount of $250,000. The officers of the company are: J. W. Menefee, president; George T. Williamson, treasurer; J. S. Thompson, secretary, all of Graham.

WILKESBARRE, PA.—The permanent organization of the Hazleton, Weatherly & Mauch Chunk Electric Railway has been effected. The officers of the company are as follows: President, Frank W. Larned; vice-president, Elmer Warner; secretary and treasurer, A. H. Bloom; assistant secretary, Ira W. Barnes. Arrangements have been perfected whereby work on the line will be started as soon as the required franchises are granted. The road is to run from Hazleton to Nesquehoning, where it will connect with the trolley now building from Lansford to Mauch Chunk.

LEGAL NOTE.

SINGLE-PHASE MOTOR DECISION—Judge Townsend, of the United States Circuit Court of the Southern District of New York, has handed down a decision of considerable interest in the suit of Thomson-Houston Electric Company, as complainants, *vs.* the Wagner Manufacturing Company and A. H. Mustard, defendants. This suit involves the alleged infringement by the Wagner company of the patents of Elihu Thomson for an alternating-current motor. The judge holds that the defendants are entitled to the benefit of the rule requiring a narrow construction of such a patent. Upon said construction, it is held, there is no infringement and the bill is consequently dismissed.

ELECTRICAL SECURITIES.

There has been a considerable decrease in the volume of speculation during the past week. This has been expected for some time, however, and there is no apprehension felt that it is evidence of more than a temporary dominance of bearish conditions. Attention in financial circles has again been directed to the outcome of the Northern Securities litigation to determine the legality of that corporation. This decision will mean much to the financial districts, and if it is favorable it is expected that similar combinations of allied railroad systems will be formed, which will provide valuable stimulus to the stock market. The opinion is growing that when the matter is decided by the United States Supreme Court a favorable finding will be discovered. The recent collapse of several factors opposing this corporation has had a good deal to do with the expressions of confidence in the company's final triumph.

With the return of the bulk of the anthracite coal miners to their work during the past week, the feeling of insecurity as to a possible famine of this fuel has been almost entirely eliminated. Considerable unrest is felt, however, as to the outcome of the debatings of the commission appointed by the chief executive, and no matter which side is held to be censurable, there will no doubt be dissatisfaction for some little time.

ELECTRICAL SECURITIES FOR THE WEEK ENDING OCTOBER 25.

New York:	Closing.
Brooklyn Rapid Transit	63
Consolidated Gas	219¼
General Electric	187
Manhattan Elevated	135
Kings County Electric	207
Metropolitan Street Railway	140
New York & New Jersey Telephone	159
Westinghouse Manufacturing Company	218

Westinghouse made a gain of 1 point for the week. The directors of the company have declared the regular quarterly dividend of 1¾ per cent upon the assenting stock, payable November 15.

The American District Telegraph Company has declared a semi-annual dividend of 1 per cent, payable November 15.

New York & New Jersey Telephone is stronger at the end of the week than for the same time the week before, sales having brought the stock up 3 points to 159.

Kings County Electric Light and Power is standing at a higher figure than last week, rising 3 points to 207.

It has been stated that the General Electric Company is likely to form a subcompany to take care of its steam turbine interests, and stockholders will probably receive valuable rights.

Boston:	Closing.
American Telephone and Telegraph	164½
Edison Electric Illuminating	267½
Massachusetts Electric preferred	95½
New England Telephone	138
Western Telephone & Telegraph preferred	99

The directors of the New England Telephone and Telegraph Company have declared a dividend of $1.50 per share, payable November 15, to stockholders of record October 31, 1902.

Massachusetts Electric held strong, touching 38¾.

American Telephone lost ½, going to 164½, a net loss of 3 points for the week.

Philadelphia:	Closing.
Electric Company of America	9¾
Electric Storage Battery common	87
Electric Storage Battery preferred	87
Philadelphia Electric	8⅝
Union Traction	47
United Gas Improvement	114¼

There were no changes worthy of notice in the local securities during the week.

Chicago:	Closing.
Chicago Edison Light	107
Chicago Telephone	168
Metropolitan Elevated preferred	89⅞
National Carbon common	30
National Carbon preferred	100
Union Traction common	18
Union Traction preferred	50

The Chicago Edison directors have declared the regular quarterly dividend of 2 per cent, which was payable November 1.

ELECTRIC LIGHTING.

LOS ANGELES, CAL.—The city council has granted the Los Angeles Lighting Company a one-year's contract for street lighting.

HELENA, MONT.—The power-house of the Helena Light and Power Company has been destroyed by fire, the loss amounting to $100,000.

BRIDGEHAMPTON, L. I.—The new electric light company at Southampton is arranging to extend its lines through this village and into Easthampton.

ESCANABA, MICH.—The city will purchase the gas and electric plant of the lighting company for $48,000, this having been decided by a special election.

ROCHESTER, N. H.—The city council has voted to make a contract for street lighting with the Union Gas and Electric Company for a period of ten years.

WEST SENECA, N. Y.—A committee has been appointed to decide upon the location of electric lights in the town. It is expected that they will be in operation November 15.

SEA ISLE CITY, N. J.—The city council has contracted with the Electric Light, Power and Water Company to furnish electric light to the village, the contract to run until July 1, 1903.

FAYETTESVILLE, N. C.—Work is going on for the construction of a power-house for the electric street lighting plants. The contract calls for the completion of the work by December 1.

PAULS VALLEY, OKLA.—The city has granted permission to Texas parties to put in an electric light plant. Work is to begin within sixty days and is to be completed inside of six months.

BATH, N. Y.—The Bath Electric and Gas Light Company, controlled by T. L. and N. W. Dalton, has been sold to King Brothers, of Philadelphia. The purchase price is said to be close to $100,000.

LLANO, TEX.—William Stein, New Berlin, has sold the franchise and property of the Llano Water, Power and Light Company, comprising the water and electric light system of Llano, to W. W. Canine.

LE ROY, N. Y.—The plant of the Le Roy Gas and Electric Company has been sold to D. C. Howard Prentice, who is also interested in the Hydraulic Electric Company and the Le Roy Power Milling Company.

HELENA, MONT.—The Powell Power Company has been incorporated with a capital of $200,000. The incorporators of the company are: George H. Casey, J. K. Heslett, J. F. Cown, of Butte. Butte will be the principal place of business.

ALLIANCE, OHIO—Plans have been approved by the Pennsylvania company for an immense lighting plant at Conway, Pa., on the Fort Wayne. The building is the first of several to be erected at different points on the system west of Pittsburg. Work will begin at once, and the plant will be completed by January 1.

OBITUARY NOTICE.

PROFESSOR SIDNEY HOWE SHORT died on Tuesday, October 21, in London, England, following an operation for appendicitis. Professor Short was very prominently identified with electrical interests, and did much pioneer work in the development of electric railways. He was born in Ohio, and was graduated from the Ohio State University in 1878. He established the Short Electric Railway, of Columbus, and at one time was connected with the Walker Electric Company, of Cleveland, Ohio. He was a professor in Denver University for several years, during which time he invented his electric car, it being first tried on the university grounds. Lately, Professor Short had been engaged as consulting engineer in London with the Dick-Kerr Electrical Company. Professor Short and his wife went to London to live about four years ago, their four children remaining in this country to attend school. They have since made several trips to New York, and were making plans to sail for this side within a week. Up to his last illness, Professor Short had been in good health, and the news of his untimely death will be a great shock to his many friends throughout the country. He was forty-three years of age, and had been engaged in electrical work for the last twenty-four years.

INDUSTRIAL ITEMS.

JAMES McCREA & COMPANY, 67 West Washington street, Chicago, Ill., are the manufacturers of a number of steam specialties which find many users in electric light and power stations.

THE MARSHALL-SANDERS COMPANY, Boston, Mass., is to be complimented upon the distribution of its attractive art calendar. This runs from October, 1902, through December, 1903.

ADAMS-BAGNALL ELECTRIC COMPANY, Cleveland, Ohio, manufacturer of arc lamps, it is said, has sufficient orders on its books at the present moment to keep its shops busy for many weeks ahead.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., wishes to call attention to Columbia lamps. Any buyer of incandescent lamps will be sent upon request an attractive pamphlet entitled, "That Question of Light."

H. C. McAULIFFE, Park Row Building, New York city, has a very complete line of electrical testing instruments which have been slightly used. Prospective purchasers of this kind of apparatus will receive full information upon request.

THE DE LAVAL STEAM TURBINE COMPANY, New York city, has issued in bulletin form a test of a 300-horse-power turbine dynamo by Dean & Main. This matter was discussed in detail in a recent number of the ELECTRICAL REVIEW.

THE STANLEY ELECTRIC MANUFACTURING COMPANY has recently opened a sales office in Atlanta, Ga., to take care of the increasing demand for S. K. C. apparatus in the South. The office is in the Empire Building and is in charge of Mr. George P. Hardy.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., is advising the trade to anticipate its requirements in Guttman wattmeters. It is claimed that the growing popularity of this meter is bringing a rush of orders that is bound to tax the capacity of the factory.

THE HUNTER FAN AND MOTOR COMPANY, Fulton, N. Y., has added a new story to its large building. This will give the company increased facilities for handling a large amount of new business and has been made necessary by the increasing demand for its specialties.

THE PITTSFIELD ELECTRIC COMPANY, Pittsfield, Mass., manufactures a complete line of electrical cooking apparatus. This company will be pleased to furnish full information to any one who is desirous of availing himself of the efficiency of the electrical cooking apparatus.

THE SENECA FALLS MANUFACTURING COMPANY, Seneca Falls, N. Y., is the manufacturer of "Star" foot and power screw cutting engine lathes, "Crown" lathes, and machine tool accessories and specialties. A recent catalogue describes this apparatus in detail and illustrates many applications of such devices.

THE HAINES & NOYES COMPANY, Chicago, Ill., has now moved to its new factory and in the very near future will have its increased mechanical equipment in operation. By this movement the company is largely increasing its establishment and will produce a far larger amount of telephone apparatus than heretofore.

THE ARNOLD ELECTRIC POWER STATION COMPANY, Chicago, Ill., is acting as consulting engineer for the rebuilding of the central power plant at DeKalb of the DeKalb & Sycamore Electric Company. This is to provide for the increasing business and to furnish power for an interurban line now being built between DeKalb and Sycamore, Ill.

THE CASSEL AUTOMATIC WATER MOTOR COMPANY has published a very complete catalogue, descriptive of its automatic water-wheels. This volume takes up in detail the application and regulation of water-wheels of different types, and this is supplemented by a great deal of information with regard to hydraulics in general. This will be sent upon request.

MR. WILLIAM K. BASSFORD, JR., Newark, N. J., consulting engineer and builder of engine-type generators and electrical machinery, is installing a number of plants of considerable magnitude in different sections of the country. Mr. Bassford has been very successful in his work, and will be pleased to refer any prospective purchasers to a number of patrons who will be pleased to furnish testimonials as to his work.

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, Chicago, Ill., is publishing a book of testimonials which bears a significant title page entitled "The Express and Some of Its Stopping Places." This contains the commendations of a large number of users of "Express" switchboards of different capacities, and makes interesting reading for those about to look into the question of switchboard practice.

THE GOODALL WORSTED COMPANY, Sanford, Me., is building a large addition to its present works and has found it necessary to considerably enlarge the power plant. A recent purchase from the Westinghouse Electric and Manufacturing Company includes a 400-kilowatt, two-phase, alternating generator which will be belted to an 800-horse-power Brown engine. The generator will furnish power to all departments of the plant by means of induction motors, and will provide current through transformers for lighting at 104 volts.

THE DEPARTMENT OF EDUCATION, of the Borough of Manhattan, has issued a series of bulletins of free lectures to the people. This includes a course of twelve lectures on electricity, a course of eleven lectures on European countries, eleven lectures on physics and electricity, nine lectures on South American geography, eleven lectures on North and South America, nine lectures on natural science, six lectures on American history, four lectures on American literature, eleven lectures on electricity and chemistry, eleven lectures on descriptive geography, and ten lectures on science.

MR. JAMES P. GILBERT, who on November 1 assumes the management of the Standard Electrical Manufacturing Company at Niles, Ohio, which company will manufacture a comprehensive line of incandescent lamps, announced to a representative of the ELECTRICAL REVIEW a few days ago that the company would be operated as an entirely independent concern. He further added that the company would not be controlled nor have relations so far as agreement or combination purposes are concerned. As announced in the recent issues of this journal, Mr. Gilbert has been for eight years general superintendent of the New York & Ohio Company at Warren, Ohio, and it is believed that under his management the company at Niles will offer an excellent product of incandescent lamps, and in large quantity.

THE HOLOPHANE GLASS COMPANY, 15 East Thirty-second street, New York city, is very busy supplying orders for a great variety of Holophane globes. Holophane glass is designed to accomplish first, a complete diffusion and softening of light, securing the removal of all glare, streaks and dazzling points. Second, a better distribution of the rays, giving the strongest light where the greatest illumination is desired, securing increased illumination and consequent economy. The Holophane globes are made of a perfectly colorless transparent glass of uniform quality, which is pressed and thoroughly annealed to produce toughness. The globes are provided with vertical prismatic ribs on the interior, and horizontal prismatic ribs on the exterior. The interior ribs are visible and the surface of the globe appears to be divided up into prismatic points arranged in a regular row. Each rib has a number of separate faces with separate duties to perform. The prisms and faces are accurately calculated by the laws of geometrical objects and are scientifically arranged with mathematical precision to combine the phenomena of both refraction and reflection. The Holophane glass globes are made in three general classes; class A for use where the light is directly above the object requiring the strongest illumination; class B where a strong illumination is required in all directions below the horizontal. These give a maximum of light at an angle of forty degrees below the horizontal; class C is for the illumination of large areas where the lights are placed far apart. These give a maximum of light at an angle of ten degrees below the horizontal. Holophane globes are made for arc and incandescent electric lights, Nernst lamps and all forms of incandescent gas and kerosene lamps. An enquiry department has been established by the company, the duties of which are to answer all questions in regard to the number and size of lights and their correct location in order to secure the best illumination. The company has recently issued a handsome catalogue, which accurately describes and illustrates every variety of the Holophane glass globes.